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## NEOTROPICAL RAPTORS AND DEFORESTATION: NOTES ON DIURNAL RAPTORS AT FINCA EL FARO, QUETZALTENANGO, GUATEMALA

JAY P. VANNINI

**ABSTRACT.**—Twenty-one species of diurnal raptors (Family Cathartidae, Pandionidae, Acciptridae and Falconidae) are reported from Finca El Faro, Quetzaltenango, Guatemala. Observations were made from 1 March 1987 through 5 March 1989. Data are also included for an additional eleven species of diurnal raptors whose presence is suspected. Comparisons with known diurnal raptor components of 4 well-studied Central American parks and reserves are presented.

Our current knowledge of ecological requirements of tropical raptors is poor (Newton 1979; Thiollay 1985a). A recent summary of data available on tropical forest raptors suggests a dearth of basic natural history data for most species (Thiollay 1985a).

In particular studies on diurnal raptors of the Neotropics are lacking. A review of recent literature (e.g., Burton 1983) suggests that older references continue to be cannibalized (Dickey and van Rossem 1938; Blake 1953; Slud 1964; Wetmore 1965; Smithe 1966; Brown and Amadon 1968; Monroe 1968; Land 1970; Meyer de Schauensee 1970; Alvarez del Toro 1971). While recent publications on the region's avifauna have added minor ecological notes and distributional data (Ridgely 1976; Blake 1977; Parker et al. 1982; Hilty and Brown 1986), few comprehensive studies have been made. Notable exceptions deal with reproductive biology of more spectacular species (Harrison and Kiff 1977; Rettig 1978; Bierregaard 1984; Lyon and Kuhnigk 1985; Jenny and Cade 1986). While publications dealing with diurnal raptors of the Indo-australian region have provided us with insight into the habits of these birds (Hollands 1984; Coates 1985), raptors of the Neotropics remain largely neglected.

Guatemala's avifauna is among the better studied in Central America (Salvin and Godman 1897-1904; Griscom 1932; Smithe 1966; Land 1970; Vannini, unpubl. ms.). The known avifaunal component totals 714 species (Vannini, unpubl. ms.). Diurnal raptors comprise 49 species or 6.86% of the country's

total avifauna. This percentage relationship is the highest for a political region in the northern and middle Neotropics (this study). Guatemala's diurnal raptors include 6 migrant taxa which spend varying periods of time in the Nearctic region; 35 resident species and 8 species with migrant and resident populations (Land 1970; Vannini, unpubl. ms.).

Finca El Faro is a privately owned plantation on Guatemala's Pacific versant (Fig. 1), owned and managed by Agroindustrias Tamer, S.A. The plantation has been the focus of a joint research project since 1 March 1987 between the Fundación Interamericana de Investigación Tropical (FIIT) and the University of Texas at Arlington (UTA). During the course of floral and faunal inventories a number of observations were made on the diurnal raptors of this reserve.

This paper summarizes the data collected during the course of these inventories and compares the known diurnal raptor fauna of Finca El Faro with other well-studied parks and reserves in the northern Neotropics in an attempt to demonstrate that plantation areas are utilized by a wide range of native and migrant raptors, and may provide valuable "buffer" areas when adjacent to native forest.

### STUDY SITE AND METHODS

Finca El Faro is a 670 ha subtropical plantation located on the south-western slopes of Volcanes Santa Maria and Santiaguito, in the department of Quetzaltenango, Guatemala. Elevations within the farm range from ca. 800-2500 m. Mean annual precipitation at 875 m elevation is



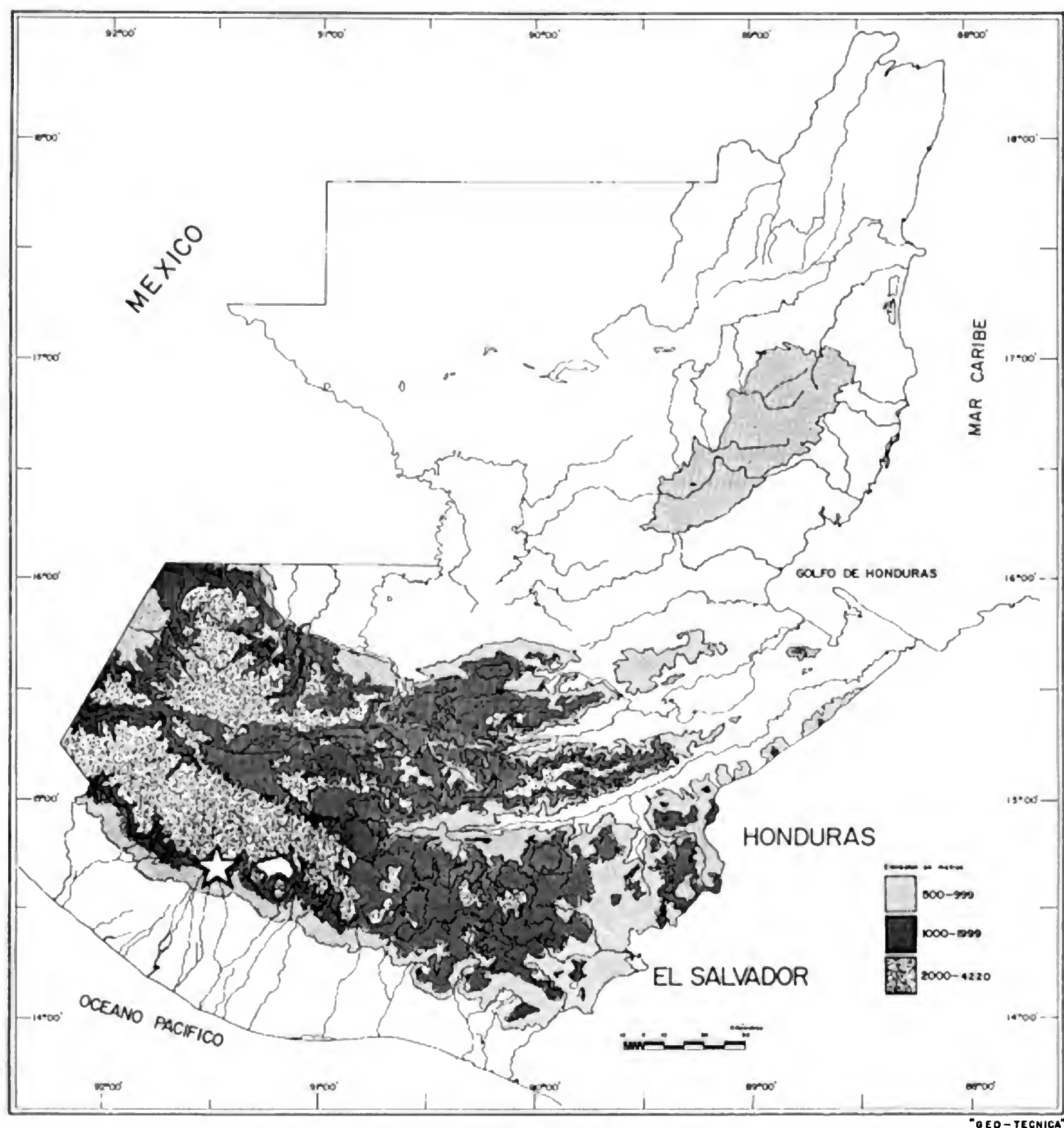


Figure 1. Hypsometric map of Guatemala and Belize showing the location of Finca El Faro (Star) in southwestern Guatemala.

ca. 4500 mm with peaks from late May-September (INSIVUMEH 1969). The site has been under continuous cultivation since the early 1930s and has been subjected to several devastating periods of volcanic activity since the 1902 eruption of Volcan Santa Maria (McBryde 1945). The most dramatic of these nuée eruptions occurred in November 1929 and 19 April 1973 (Rose, unpubl. ms.).

Presently, the site is being managed as a diversified plantation and premontane research facility. Land use

analysis shows ca. 220 ha under coffee (*Coffea arabica*), ca. 80 ha under cardamom (*Elettaria cardamomum*), ca. 40 ha under macadamia (*Macadamia integrifolia*) cultivation and ca. 330 ha as wildlife refuge area.

Conditions within the cultivated areas range from high density coffee plantings under heavily pruned *Inga* sp. shade through "climax plantation" cardamom under forest canopy with a considerable amount of native undergrowth. The area is rich in hydrological resources. Largest streams

on the farm are Rios Nima 1 and 2 which originate on the property above 2000 m elevation.

Vegetation in the wildlife refuge area dates primarily from April 1973 and is extremely dynamic. Although there are few trees which exceed 50 cm dbh, natural regeneration has been rapid. Conditions within this successional forest are comparable to those encountered in many mature premontane forests elsewhere along Guatemala's Pacific versant except tank bromeliads and orchids are rare (pers. obs.).

Data for this study were collected on weekends between 0500 and 1900 H from March 1987 through March 1989.

**Road Surveys** (adapted from Fuller and Mosher 1987). The farm has ca. 15 km of well-ballasted access roads at elevations from 800–1480 m on the east reserve entrance to ca. 1650 m on the west reserve entrance. Observations were made from various four wheel drive vehicles in the company of other observers. Vehicles were stopped only when raptors were observed and no standard speed was employed during the course of the study.

**Foot Surveys** (adapted from Fuller and Mosher 1987). In addition to use of vehicle access roads for foot surveys, the wildlife refuge area has 7.5 kms of stepped trails, 2 m wide which were used for surveys. Elevations on the trail range from 1480–2200 m (range = 720 m). Although steep in sections, visibility from the trail is generally excellent. Artificial light gaps have been cut in order to increase visibility and to create edge within the forest. Observations were made while walking the trail or standing at light gaps in the company of other observers. No standard speed was employed during the course of the study.

**Mist Nets** (adapted from Karr 1979). Three primary mist net stations have been established for avian and chiropteran inventories, located at 875 m (plantation); 1100 m (plantation/riparian forest) and 1450 m (premontane forest edge). Nets are generally used in pairs and range from 5–19 m in length and have 3–4 trammels. Nets are set at heights varying from ground level to 8 m and are supervised by a minimum of 2 observers. Although mist nets resulted in only 2 diurnal raptor captures from January–June 1988, the presence of vocalizing birds in mist nets or in hand attracted raptors to within close range on many occasions.

Observations were made using Bushnell 10 × 40 binoculars, Swift 10 × 44 binoculars, Jason 7 × 50 binoculars and a Celestron 100–200× spotting scope anchored on any convenient perch. Photographic records of individual diurnal raptors and intraspecific/interspecific interaction were made whenever feasible with Canon A1 and AE1 35mm cameras with lenses ranging from 28–500 mm.

Identification procedures at Finca El Faro require: voucher specimens in the case of plants and lower vertebrates; unmistakable photographic identification or multiple confirmations by reliable fieldworkers familiar with the taxon in question for birds and medium to large mammals (see Acknowledgments).

#### SPECIES ACCOUNTS

##### **Turkey Vulture** (*Cathartes aura*)

Turkey Vultures are common throughout the year at all elevations within the farm. Although generally

not as common as *Coragyps*, during October–November when migrants are present, Turkey Vultures may be observed in considerable numbers above 1100 m elevation. Both adult and juvenile birds have been recorded.

##### **Black Vulture** (*Coragyps atratus*)

Black Vultures are the most commonly observed diurnal raptor at Faro during all periods except October–November. Although observed at all elevations within the farm, Black Vultures are most common at elevations below 1450 m. Due to limited refuse availability, this species has not become a problem scavenger as at other parks and reserves in Central America (Burnham et al. 1988; pers. obs.)

##### **Osprey** (*Pandion haliaetus*)

A single juvenile Osprey was observed on 14 February 1988 at 875 m elevation flying eastward ca. 10 m overhead. No other observations of this species have been made and Osprey are obviously rare transients at Faro. Several coastal avian species frequently are observed at higher elevations along the volcanic chain (Land 1970; pers. obs.).

##### **Cooper's Hawk** (*Accipiter cooperi*)

Cooper's Hawks have been observed on 4 occasions at Faro at elevations ranging from 1100–1600 m. On 14 November 1987 a juvenile was observed in company with a mixed flock of migrating and resident raptors. On 12 March 1988 an adult female was observed soaring over gallery forest at 1100 m. On 8 May 1988 a poorly moulted adult was observed soaring over an area with newly planted coffee and on 13 November 1988 an adult was observed soaring over premontane forest edge. Cooper's Hawks are rare migrants in Guatemala, and observations during this study represent the first confirmations of this species' presence in the western highlands.

##### **Sharp-shinned Hawk** (*A. striatus*)

A migrant species. Sharp-shinned Hawks are commonly observed at Faro at elevations ranging from 1100–1600 m from January–April. Two adult females were mist-netted during March 1988. Pursuit and capture of Swainson's Thrush (*Catharus ustulatus*) has been observed, and collected prey remains have included doves (*Leptotila* sp.). During periods of heavy *Inga* sp. and *Cecropia* sp. flowering in February, up to 3 adult Sharp-shinned Hawks



have been observed aggressively defending small territories (<3 ha) containing high densities of native and migrant passerines.

#### **Zone-tailed Hawk** (*Buteo albonotatus*)

Zone-tailed Hawks are frequently observed throughout the year at Faro from ca. 900–1200 m elevation. At least 1 adult pair is resident in the area and single adults are observed daily during the dry season (January–May). An adult was observed to maintain a foraging territory during February–March 1988. Prey were primarily Basilisks (*Basiliscus vittatus*) and Ameivas (*Ameiva undulata*). Captures were effected by soaring over recently planted coffee and stooping from an altitude of 50 m. Success rate during brief observations appeared to be ca. 25% and observations during this study represent the first confirmation of this species' presence in the western highlands.

#### **Short-tailed Hawk** (*B. brachyurus*)

This small hawk is common throughout the year at elevations ranging from ca. 800–1700 m. At least 2 pair, and possibly a third, are believed to nest in the area. Three color morphs; white-chested, grey-chested and uniformly dark birds were observed. Courtship flights occurred from February–April 1988. Three Short-tailed Hawks were observed soaring at ca. 1500 m elevations on different dates in May 1988 and may have represented a breeding pair with the fledgling(s). An immature bird was observed perched and eating a lizard at 1550 m on 5 March 1989. Reported observations represent the first confirmation of this species on Guatemala's Pacific versant.

#### **Red-tailed Hawk** (*B. jamaicensis*)

Red-tailed Hawks are infrequently observed throughout the year on Faro at elevations ranging from ca. 1100–2200 m. During January 1988 a pair was observed displaying over grasslands and pine forests of upper Volcan Santa Maria. No juveniles have been observed. Red-tailed Hawks are normally restricted to open areas on Faro and appear to reach lower elevations via the Santiaguito/Rio Nima 2 corridor, thus avoiding the belt of premontane forest between 1500–2200 m. However, on 18 February 1989 a uniformly dark Red-tailed Hawk was observed soaring over premontane forest canopy at 1750 m.

#### **Roadside Hawk** (*B. magnirostris*)

Surprisingly, Roadside Hawks are uncommon on Faro. Although year-round residents and breeding birds occur in the area, encounters are infrequent. Juvenile and adult birds have been observed at elevations ranging from 875–1100 m. I hypothesize that diversity of habitats on Faro, in addition to competition from other small raptors, does not favor high Roadside Hawk populations. In sugarcane (*Saccharum officinalum*) fields within 15 km airline of Faro the species utilizes power poles as perches and is present at high densities where there is little or no competition from other similar-sized diurnal raptors (per. obs.).

#### **Grey Hawk** (*B. nitidus*)

Grey Hawks are abundant raptors at Faro at elevations ranging from ca. 800–1500 m. Several adult pairs are conspicuous throughout the year. Soaring aggregations of up to 4 birds have been observed and aggressive interactions between individuals over territories are frequent. Grey Hawks are adaptable birds with catholic diets and may use several techniques to capture prey. In most cases the bird simply drops from a perch onto small vertebrates such as lizards and snakes. During March 1988 several unsuccessful attempts by an adult to capture feeding Green Parakeets (*Aratinga holochlora*) were observed. Prey capture technique was strongly reminiscent of that used by *Accipiter* spp. and were made by gliding at high speed under plantation canopy. Most often observed in open habitats on Faro, 1 pair is most regularly observed perched and hunting in mature, enclosed plantation.

#### **Broad-winged Hawk** (*B. platypterus*)

A single adult Broad-winged Hawk was observed on Faro at 875 m elevation 17 January 1988. The bird soared briefly over coffee plantation and moved slowly east. Commonly observed in the western highlands (Land 1970; pers. obs.), this migrant species may be more common at upper elevations than this single record would suggest.

#### **Swainson's Hawk** (*B. swainsoni*)

A migrant species. Small aggregations of Swainson's Hawks are frequently observed during migration (September–October and April–May). Individuals are uncommonly observed September–May. On several occasions in October–November 1987 I noted

single birds gliding eastward along the volcanic chain at approximately the elevation of the cone of Volcan Santa Maria (3772 m). Several birds were observed to drop rapidly to an altitude of 1200–1500 m in order to group with other Swainson's Hawks and migrating Turkey Vultures.

#### **Solitary Eagle** (*Harpyhaliaetus solitarius*)

On 2 occasions during January–February 1988, I briefly observed what I am certain were adult Solitary Eagles soaring at elevations from ca. 1000–1100 m. Subsequent observations by a field associate familiar with Solitary Eagles elsewhere confirmed the presence of at least 1 adult bird on Faro. A single observation on 23 June 1988 of a juvenile bird at ca. 1500 m elevation was made by a group of biologists from the University of Texas at Arlington. Likely, a pair of these eagles breeds on the upper forested slopes of Volcan Santa Maria or Volcan Zunil immediately to the east. Observations during this study represent the first confirmation of this species on Guatemala's Pacific versant.

#### **White Hawk** (*Leucopternis albicollis*)

A single White Hawk was observed soaring over the runway on Faro at 850 m elevation on 15 March 1987. Although conspicuous at a distance when sitting along forest edge, White Hawks may occur in mature plantation or forest without being observed for some time. Comments by agricultural laborers on the neighboring La Florida plantation lead me to believe that investigation there would reveal a pair of these birds.

#### **Ornate Hawk-Eagle** (*Spizaetus ornatus*)

A large adult female Ornate Hawk-Eagle was observed at close range on 19 July 1987. The bird was perched 15 m from the ground in a large *Cecropia* sp. at 1480 m elevation, exactly along the wildlife refuge area boundary. The bird called constantly for 5 min with crest raised, then soared slowly downhill over newly-planted coffee. Two additional observations were made in 1987; 1 of a much smaller bird flying over gallery forest and plantation along Faro's eastern border at ca. 1300 m elevation. No observations were made in 1988 or early 1989. I suspect that the birds breed further east on Volcan Santa Maria and visit Faro occasionally. Observations recorded during this study represent the first

confirmation of this species for the western highlands.

#### **Tyrant Hawk-Eagle** (*S. tyrannus*)

Tyrant Hawk-Eagles are commonly observed on Faro between ca. 800–3000 m. Aerial display flights by a resident pair were observed during March–April 1988. A complex courtship display flight involving contact and roll-overs was observed in the company of Peregrine Fund biologists on 18 February 1989 at ca. 2200 m. The pair is believed to nest on the reserve's lowest edge at 1400 m or just east of Faro. From February–June 1988, the adult male was observed soaring daily from 0900–1100 H. Vocalizations were made constantly while soaring and could be heard for several kms on clear days. On 27 February 1988 a juvenile female made a very close approach (<8 m) while I was removing a protesting Grey-cheeked Thrush (*Catharus minimus*) from a mist net in riparian forest at 1100 m elevation. The bird appeared from down a gorge, adjacent to a cardamom plantation and remained perched in a *Cecropia* sp. for ca. 15 min. The hawk-eagle appeared extremely interested in the thrush vocalizations, raising the crest and craning to obtain a better view when the thrush struggled in my hand, yet remarkably unconcerned over the excited conversation I was having with a field assistant. A juvenile Tyrant Hawk-Eagle, possibly the same individual, has since been observed close to the house at 875 m on several occasions from March–December 1988. Although no observations of hunting behaviour have been witnessed, Crested Guans (*Penelope purpurescens*) and Magpie-Jays (*Calocitta formosa*) have been observed to give alarm when a Tyrant Hawk-Eagle passes overhead. Observations reported in this study represent the first confirmation of this species' presence in the western highlands.

#### **Bat Falcon** (*Falco rufigularis*)

Individual female Bat Falcons have been observed on several occasions at 875 m elevation. On 17 June 1988, several biologists from the University of Texas at Arlington observed a bird at close range near the house. The Bat Falcon resulted in omnipresent flocks of Vaux's Swifts (*Chaetura vauxi*) and White-collared Swifts (*Streptoprocne zonaris*) "skying up," although no chases were observed. An adult female was observed hunting Vaux's Swifts during January 1989 by a field associate. Interestingly, several cap-



tive Bat Falcons are housed in a breeding chamber nearby. Although no interaction was witnessed, the presence of a vocal breeding pair may attract wild individuals. Bat Falcons are extremely rare on Guatemala's Pacific versant. Indiscriminate use of organochlorine pesticides may be affecting populations in certain areas (Cade 1982). Captive-bred Bat Falcons will be released at Faro during 1989.

#### **American Kestrel** (*F. sparverius*)

A migrant species; presence of resident subspecies suspected. Kestrels were frequently observed from October 1987 through April 1988 and appear to establish winter territories. At least 1 adult male was observed on 25 June 1988, suggesting that it may also be present as a resident. Kestrels favor newly planted coffee plantations and areas adjacent to Santiaguito at elevations from ca. 1100–1500 m but have not been seen in mature plantations or in the wildlife refuge area. As newer plantings mature, kestrels may ultimately be restricted to Rio Nima 2 drainage on Faro.

#### **Laughing Falcon** (*Herpetotheres cachinnans*)

A single Laughing Falcon was briefly observed on 14 November 1987 in an aggregation of soaring migrant and native raptors at ca. 1300 m elevation. An individual was observed 30 June 1988 perched in a dead tree near the plantation house at 875 m. Absence of a breeding population is surprising. Conditions on Faro favor Laughing Falcons, and common prey items such as medium-sized lizards and snakes are abundant (Campbell and Vannini 1988). Presently, the Laughing Falcon is considered a transient at El Faro.

#### **Collared Forest-Falcon** (*Micrastur semitorquatus*)

A resident Collared Forest-Falcon was heard calling from March–May 1987 and during April 1988 at ca. 1600 m in early evening. Although the bird responds to imitations of its call, this individual has not been seen. Prey remains found within 100 m of its preferred perch include White-faced Quail-Dove (*Geotrygon albifacies*) and Ruddy Quail-Dove (*Geotrygon montana*). Size of the doves and frequency of remains found at this perch suggest kills by the forest-falcon. A Collared Forest-Falcon was flushed in a mature macadamia orchard on 10 April 1988 at ca. 1000 m elevation. A large flock of Red-billed Pigeons (*Columba flavirostris*) flushed seconds later,

just below where the bird was perched. On 4 March 1989 at 1830 H an adult female was observed to fly over a river canyon at 1650 m and perch for ca. 15 min under canopy. The observations during the course of this study represent elevational records for the species in Guatemala.

#### **Crested Caracara** (*Polyborus planca*)

Caracaras are irregular transients at Faro throughout the year. Individuals have been observed at elevations from ca. 800–900 m, and occasionally an individual may take up residence for several days near the plantation house at 875 m. Caracaras frequently harass captive animals in the breeding project, and the species is very common at lower elevations within 10 km airline of Faro.

#### **SPECIES WHICH POSSIBLY OCCUR AT FINCA EL FARO**

##### **King Vulture** (*Sarcoramphus papa*)

Probable. King Vultures are rare or uncommonly observed on Guatemala's Pacific versant due to extensive deforestation and improved livestock management (Dickerman, unpubl. ms.; pers. obs.). Occasionally still observed near Siquinalá, Escuintla, the bird is probably a rare transient in western Guatemala.

##### **Bicolored Hawk** (*Accipiter bicolor*)

Probable. Bicolored Hawks are known from isolated locations on the Pacific versant (Griscom 1932) and range to elevations of 1350 m in Guatemala (Land 1970). A cryptic bird which does not vocalize frequently, acoustical luring or deep forest mist net stations may be required to confirm presence. On 5 March 1989 I briefly observed a medium-sized, white breasted *Accipiter* sp. at 1550 and 1700 m elevation. Suspected presence of a resident Sharp-shinned Hawk (*A. striatus chionogaster*) which is similar to pale morph Bicolored Hawks made a positive identification difficult.

##### **Common Black Hawk** (*Buteogallus anthracinus*)

Known from similar elevations and habitat within 15 km airline (Griscom 1932). Now rare on Guatemala's Pacific piedmont.

##### **Marsh Hawk** (*Circus cyaneus*)

Probable. Marsh Hawks are known from within 10 km airline at Quetzaltenango (Griscom 1932).



Presence as a migrant at elevations >2200 m in grassland almost certain.

**White-tailed Kite** (*Elanus caeruleus*)

Known from similar elevations and habitat within 15 km airline (Vannini, unpubl. ms.) and rapidly expanding its range in northern Central America.

**Black Crane Hawk** (*Geranospiza nigra*)

Rare or uncommon on Guatemala's Pacific versant and known from very few localities at upper elevations along the piedmont (Griscom 1932; Land 1970).

**Double-toothed Kite** (*Harpagus bidentatus*)

Probable. The species has only recently been confirmed as a resident of Guatemala's Pacific versant (pers. obs. with photo). An adult *Harpagus* was reportedly observed at close range on Faro in mature plantation during June 1987 (J. Darling, pers. comm.) but presence remains unconfirmed.

**Grey-headed Kite** (*Leptodon cayanensis*)

A lowland species in much of Guatemala. Known from 2 localities in the area; Finca El Carmen, 25 km airline from Faro (pers. obs.) and Mazatenango (P. Rockstroh, pers. comm. with specimen deposited at National Museum of Natural History). Both records are from mature plantation at somewhat lower elevations.

**Merlin** (*Falco columbarius*)

Known from very few records in Guatemala (Land 1970) but recorded at low and middle elevations along the Pacific versant as a migrant.

**Orange-breasted Falcon** (*F. deiroleucas*)

A remote possibility. A single specimen known from the Pacific versant of Guatemala is from Finca El Ciprés, a plantation on the southern slope of Volcan Zunil, 15 km airline from Faro at 600 m elevation (Griscom 1932). A large tract of pristine premontane and montane forest remains on the southern slope of Zunil and the eastern face of Volcan Santa Maria, although conditions described by Jenny and Cade (1986) as required for Orange-breasted Falcons have not been present for decades.

**Peregrine Falcon** (*F. peregrinus*)

Probable. Peregrines are now known to occur at a variety of elevations and habitats in Guatemala

(Land 1970; J. P. Jenny, pers. comm.; pers. obs.). Peregrines are infrequently seen in the western highlands, perhaps due to the presence of few observers. The Nima 2 river valley and Santiaguito's slopes provide suitable habitat and abundant quarry for migrant individuals.

INTERSPECIFIC INTERACTION OBSERVED IN  
DIURNAL RAPTORS AT FINCA EL FARO

- 1) *Cathartes aura*: mixed flocks of *C. aura*, *Coragyps atratus* and occasionally *Polyborus planca* have been observed. On 14 November 1987, an aggregation of *C. aura*, *C. atratus*, *Accipiter cooperi* (1), *Buteo nitidus* (1), *B. swainsoni* and *Herpetotheres cachinnans* (1) was observed at ca. 1300 m elevation at 0600 H. No aggression was noted.
- 2) *Coragyps atratus*: see *C. aura*.
- 3) *Accipiter cooperi*: see *C. aura*.
- 4) *Accipiter striatus*: on 6 March 1988 an adult *A. striatus* was observed to fly out of riparian forest at 1100 m elevation and harass a soaring juvenile *Spizaetus tyrannus*. Three initial stoops were made without contact. A fourth stoop resulted in a visible strike to the eagle's dorsum. The hawk-eagle commenced vocalizing and rolled to repel a fifth stoop before rapidly moving out of the area. Intraspecific aggression between similar sized *A. striatus* was commonly observed in February–March 1988.
- 5) *Buteo albonotatus*: on 14 February 1988 an adult *B. albonotatus* and an adult *B. jamaicensis* were observed soaring at similar altitudes at 1100 m elevation at 0930 H. After ca. 15 min of observation the *B. albonotatus* was observed to stoop the *B. jamaicensis*, which rolled and vocalized. The *B. jamaicensis* moved off upslope and disappeared from view while the *B. albonotatus* continued to forage.
- 6) *Buteo brachyurus*: commonly observed soaring in company with *B. nitidus* with no apparent interaction.
- 7) *Buteo magnirostris*: occasionally observed perched or soaring near *B. nitidus*. No aggression has been noted.
- 8) *Buteo nitidus*: see *C. aura*, *C. atratus*, *B. brachyurus* and *B. magnirostris*. *B. nitidus* are commonly observed adjacent to other soaring raptors with no signs of interest or aggression. Faro has high population densities and intraspecific

aggression among unpaired *B. nitidus* is intense. A climax plantation area at 1100 m is particularly subject to confrontations between a resident pair and intruders. Up to four birds were observed disputing this area on different dates during March 1988.

- 9) *Buteo swainsoni*: see *C. aura*.
- 10) *Spizaetus tyrannus*: see *A. striatus*.
- 11) *Herpetotheres cachinnans*: see *C. aura*.
- 12) *Polyborus planca*: see *C. aura*.

#### DISCUSSION

Thiollay (1985a) listed 37 Neotropical diurnal raptors which he considers tropical rainforest species. Four are identified as being associated with small clearings, edges, etc., and select niches are suggested for many of these "rainforest" species (Thiollay 1985b). Field observations of Neotropical raptors over a 13-yr period and comments by other researchers lead me to believe that groupings are largely artificial. Although there is no way of examining precolumbian habitat partitioning in Neotropical raptors, extensive use of "atypical" habitat (dry forests, plantations), in areas often adjacent or close to pristine tropical moist or wet forests infers a certain degree of adaptability to changes. I acknowledge that such may not be so for all taxa. Seven of the species identified as tropical rainforest indicator species by Thiollay occur on Finca El Faro in successional vegetation and varying types of plantation. I emphasize that much of the vegetation at Faro may be dated. Furthermore, a careful examination of regional works on Neotropical avifauna reveals a number of observations and collections made of these same species in degraded habitat (e.g., Wetmore 1965).

Finca El Faro has a known diurnal raptor fauna that includes 21 species. Ten species are resident which have been observed at different times during the course of this study; 5 species are infrequently observed transients; 5 are long-distance migrants which were observed from October to May, and 1 has both resident and migrant populations.

Faro provides a unique opportunity to study native vertebrates under a variety of conditions and elevations. Vegetational succession studies are being effected on both man-altered habitats and forest destroyed by the 1973 *nuée ardente* of Volcan Santiago. I am not aware of any studies made on diurnal raptors in the Neotropics along an elevational transect, or community studies in degraded habitat. Al-

though it has long been suspected that species such as *Buteo magnirostris*, *Elanus caeruleus* and *Falco rufigularis* are expanding their ranges parallel to the agricultural frontier (Land 1970; Cade 1982), observations presented in this study suggest that other diurnal raptor species may benefit from habitat transformation. Comparative studies at parks and reserves with similar elevations and biotas would be of considerable value (e.g., Parque Nacional Braulio Carillo, Costa Rica).

A comparison of the avifauna and diurnal raptor faunas of 5 Central American parks and reserves and 6 political regions in the northern and middle Neotropics is presented in Tables 1-2. A clear relationship exists between the total known avifaunal component of Guatemala, Costa Rica and Panamá and the percentage composition of respective diurnal raptor faunas. Compared to these Middle American regions, Mexico (to the north), Colombia and Peru (to the south) have a significantly lower percentage of diurnal raptor species when compared to total known avifauna. It would be interesting to study the reasons behind the fact that Middle America possesses such statistically diverse diurnal raptor faunas.

Percentage relationships between the parks and reserves listed in Table 1 at lower elevations are closer than those of 2 premontane reserves (Faro/Monte Verde). Interestingly, 2 factors commonly cited as being of primary importance for preservation of diversity in the Neotropics (i.e., size and latitude), do not appear to be of real importance (Willis 1974; Thiollay 1985a). Finca El Faro and Finca La Selva are the smallest reserves listed in this study, yet have the highest number of diurnal raptor species for their elevational groups (premontane and tropical, respectively) in addition to being rich in total avian diversity (Stiles 1977; Vannini 1989).

Clearly, factors other than size and latitude *must* be taken into account when discussing biodiversity potential in Central America. Although size of reserves is of undoubted importance throughout the Neotropics (Lovejoy et al. 1984), biogeography and elevation are of primary importance in Central America. Both El Faro and La Selva are located in regions of high vertebrate diversity, with corridors of mature vegetation connected to highlands. Importance of vegetational corridors in maintaining diverse biotas has only recently begun to be understood (Hartshorn 1983). Stiles (1985) studied local movements in hummingbirds (Family Trochilidae) and found that elevational migrations effected seasonally

Table 1. A comparison of diurnal raptor diversity in 5 Central American parks and reserves.

RESERVE	LOCATION	APPROX.		ELEVATION	No. DIURNAL RAPTOR SPECIES CONFIRMED	HABITAT TYPES (HOLDRIDGE/TOSI)	TOTAL		
		LATI- TUDE	AREA (HA)				KNOWN AVIFAUNAL COMPO- NENT (TKAC)	DIURNAL RAPTOR FAUNA AS % OF TKAC	
Tikal National Park <sup>1</sup>	NE El Petén, Guate.	17°N	60 000	200–300 m	32	Tropical Dry Forest	314	10.17%	
Finca El Faro <sup>2</sup>	Palmar, Quetz., Guate.	14.5°N	670	800–2600 m	21	Subtropical Moist Forest, Lower Montane Moist Forest	178	11.80%	
Monteverde <sup>3</sup>	Cordillera Tilarán, C.R.	10°N	2 500	1200–1800 m	20	Tropical Premontane Moist Forest, Premontane Wet Forest, Tropi- cal Lower Montane Wet Forest, Tropical Lower Montane Rain Forest, Tropical Premontane Rain Forest	236	8.47%	
Finca La Selva <sup>4</sup>	Heredia, C.R.	10°N	1 350	40–130 m	36	Tropical Wet Forest, Tropical Pre- montane Wet Forest	389	9.25%	
Pipeline Road— Parque Soberania <sup>5</sup>	Gamboa, Panamá	9°N	22 000	50–200 m	33	Tropical Wet Forest, Tropical Pre- montane Wet Forest	375	8.80%	

References: <sup>1</sup> Smithe 1966; Burnham et al. 1988; <sup>2</sup> Vannini 1989; <sup>3</sup> Powell 1977; <sup>4</sup> Stiles 1977; <sup>5</sup> Gale et al. 1978.



Table 2. A comparison of avifaunal diversity and diurnal raptor diversity in 6 countries in the neotropics.

COUNTRY	TOTAL KNOWN AVIFAUNAL COMPONENT (TKAC)	TOTAL NO. OF SPECIES OF DIURNAL RAPTORS (TNDR)	% TNDR/TKAC
Mexico <sup>1</sup>	1018	58	5.70%
Guatemala <sup>2</sup>	714	49	6.86%
Costa Rica <sup>3</sup>	820	53	6.46%
Panama <sup>4</sup>	883	55	6.23%
Colombia <sup>5</sup>	1695	75	4.42%
Peru <sup>6</sup>	1689	71	4.20%

References: <sup>1</sup> Peterson and Chalif 1973; <sup>2</sup> Land 1970; Vannini unpubl. ms.; <sup>3</sup> Stiles 1983; <sup>4</sup> Ridgely 1976; <sup>5</sup> Hilty and Brown 1986, <sup>6</sup> Parker et al. 1982.

are the rule for many taxa. Similarly, Janzen (1986) discussed the importance of corridor-linked pre-montane habitats in Cordillera de Tilarán with dry forest lowlands of Guanacaste National Park in preserving diversity. Thus El Faro and La Selva, while small reserves, benefit from the pristine "sanctuary areas" which lie above, namely Volcan Santa Maria and the Cordillera Central, respectively. Tikal and Monteverde are convenient "tourist" parks, selected with criteria different from those prevalent at Faro, La Selva or Pipeline Road. That Tikal and Monteverde are also larger and more interesting to the lay visitor has *no* bearing on species diversity, a fact which should not be lost on organizations with an interest in wildlands and wildlife preservation in Central America.

Why Faro possesses such a diverse diurnal raptor fauna remains poorly understood. While elevational range on the farm and the biogeography of the western highlands points towards diversity, conventional wisdom regarding agricultural transformation in the Neotropics and subsequent impacts on wildlife point towards a depauperate fauna. Assumptions based on conventional wisdom would imply that Faro has no value as a reserve.

While we have no way of knowing what original vertebrate densities were in plantation areas, I suspect that the actual situation does not mirror pristine habitat. Although a number of environmentally sensitive vertebrates maintain breeding populations (*Pharomachrus mocinno*, *Crax rubra*, *Vampyrus spectrum*, *Plectrohyla avia*, etc.) numbers may be far lower than original densities. Undoubtedly, other taxa, including many diurnal raptors, have benefitted from agricultural transformation while others have maintained stable populations. As early as 1932, Griscom noted that the avifaunal component of mature coffee

plantations on Guatemala's Pacific versant differed little, if at all, from that of adjacent forest. Many raptors may be able to maintain viable breeding populations in areas which have suffered degradation, yet offer active protection to both prey and predator. Craighead and Craighead (1956) stated that raptor populations are related to vulnerability of prey, rather than prey densities in a given area. Successionary vegetation undoubtedly increases prey vulnerability and coupled with high densities of a highly diverse prey base may account for diurnal raptor diversity at El Faro.

I conclude that a bias by researchers towards work in mature, lowland forests in Central America results in an assumption that environmentally sensitive vertebrates, including many diurnal raptors, can exist only as associates of pristine habitat. I predict that more research in plantations and otherwise modified habitats in the northern Neotropics will reveal a greater degree of adaptability in many diurnal raptor species than has previously been suspected.

#### SUMMARY

Observations at Finca El Faro have revealed the presence of 4 diurnal raptor species not previously recorded from the western highlands of Guatemala, 2 species not previously recorded from Guatemala's Pacific versant and 1 elevational record (Land 1970). It is unlikely that these distributional records represent local displacement; there are large tracts of pristine premontane forest within 8 km airline of El Faro. Due to the nature of the faunal inventory, no attempt was made to seek nests, but courtship displays and juvenile birds observed suggest that further investigation will reveal nesting diurnal raptors.

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**Fundación Interamericana de Investigación Tropical,  
Avenida La Reforma 8-60, Oficina 1104, Zona 9,  
Guatemala City, GUATEMALA.**

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## DIETS OF BREEDING AND NONBREEDING CALIFORNIA SPOTTED OWLS

JAMES THRAILKILL AND MICHAEL A. BIAS

**ABSTRACT.**—We examined diets of breeding and nonbreeding California Spotted Owls (*Strix occidentalis occidentalis*) from the central Sierra Nevada by analyzing cast pellets. Frequencies of large and small mammal prey were significantly different between diets of breeding and nonbreeding pairs. Relative proportions of large mammal prey and biomass were significantly greater within the diet of breeding pairs than nonbreeding pairs. Further, relative proportions of small mammal prey and biomass were significantly less within the diet of breeding pairs than nonbreeding pairs. We suggest that breeding success was correlated to the greater relative proportion of large mammal prey within the diet of California Spotted Owls. Whether our results reflected prey availability was not determined.

Several studies have documented that mammals, particularly woodrats (*Neotoma* spp.) and the Northern Flying Squirrel (*Glaucomys sabrinus*) are primary food resources for Northern Spotted Owls (*Strix occidentalis caurina*) in the Pacific Northwest (Solis 1983; Forsman et al. 1984). However, little is known about the diet of the California Spotted Owl (*Strix occidentalis occidentalis*) in the Sierra Nevada. Only 2 studies are available that report food habits of 8 and 2 pairs, respectively, of spotted owls from the region (Marshall 1942; Laymon 1985). Barrows (1985, 1987) reported that breeding success of Northern Spotted Owls apparently varied with diet, with a preponderance of large prey taken during successful breeding years. We examined the diet of breeding and nonbreeding California Spotted Owls in the central Sierra Nevada to test the generality of Barrows' (op. cit.) finding.

### STUDY AREA AND METHODS

The study area was located in the central Sierra Nevada approximately 10 km north of Georgetown, Eldorado County, California. The study area was about 355 km<sup>2</sup> with elevation ranging from 366–2257 m. Habitats were typical of middle elevation mixed conifer zones of the Sierra Nevada (Verner and Boss 1980).

We located roosting and nesting owls following standard survey techniques (Forsman 1983). Breeding status was determined by feeding live mice (*Peromyscus* spp.) to either adult owl (Forsman 1983). Owl pairs were considered breeding if they nested and at least one juvenile owl was fledged. We collected spotted owl pellets from below adult roosts from May–August 1986 and 1987.

Mammalian prey were identified and counted from skulls or reconstructed appendicular skeletons, whichever gave the highest count (Forsman et al. 1984). Avian prey were identified and counted from bills. Insects were identified and counted from exoskeletal remains (Forsman et al. 1984). Mammal species were separated into 2 size classes:

large, mean weight > 100 g; and small, mean weight < 100 g, which corresponds to a natural dichotomy in the size of prey taken by spotted owls (Barrows 1985). We estimated mean weight of individual prey species from specimens and records at the Museum of Vertebrate Zoology (MVZ), Berkeley, CA. We used only specimens and records that were collected from within and surrounding counties of the study area.

We estimated diet composition for each owl pair from frequency and percent biomass of prey species and prey groups. We used *heterogeneity*  $\chi^2$  analyses to estimate if diets of breeding and nonbreeding pairs were homogeneous. Use of pooled, homogeneous data can result in a more powerful analysis (Zar 1984). We used  $\chi^2$  analysis to estimate if the overall frequency of prey items within diets of breeding and nonbreeding pairs were different. We then used a *Z* Test of proportions with correction for continuity (Zar 1984) to estimate if the proportions and percent biomass of prey groups were different between breeding and nonbreeding pairs.

### RESULTS

We collected pellets from 14 different spotted owl pairs, 5 breeding and 9 nonbreeding. A total of 139 individual prey items were identified (Table 1).

Diets of breeding and nonbreeding owl pairs were significantly homogeneous (breeding: *heterogeneity*  $\chi^2 = 6.15$ ,  $v = 12$ ,  $P > 0.05$ ; nonbreeding: *heterogeneity*  $\chi^2 = 24.56$ ,  $v = 24$ ,  $P > 0.05$ ). Overall frequencies of prey items within prey groups were significantly different between breeding and nonbreeding pairs ( $\chi^2 = 8.29$ ,  $v = 3$ ,  $P < 0.05$ ). Frequencies of birds and insects were not significantly different ( $\chi^2 = 0.08$ ,  $v = 1$ ,  $P > 0.05$ ); whereas, frequencies of large and small mammals were significantly different ( $\chi^2 = 8.26$ ,  $v = 1$ ,  $P < 0.01$ ). Because no significant differences occurred between frequencies of birds and insects within diets of breed-

Table 1. Comparison of prey found within diets of breeding and nonbreeding California Spotted Owl pairs from the central Sierra Nevada, Eldorado County, California from May–August 1986 and 1987.

PREY	BREEDING (N = 5)				NONBREEDING (N = 9)			
	FREQUENCY N%		BIOMASS (G) N%		FREQUENCY N%		BIOMASS (G) N%	
<b>Mammals</b>								
W. Gray Squirrel ( <i>Sciurus griseus</i> )	1	1.43	759	8.73	—	—	—	— <sup>a</sup>
Dusky-footed Woodrat ( <i>Neotoma fuscipes</i> )	10	14.28	2270	26.11	17	24.64	3859	50.07
S.N. Golden-mantled Ground Squirrel ( <i>Spermophilus lateralis</i> )	—	—	—	— <sup>a</sup>	2	2.90	346	4.49
N. Flying Squirrel ( <i>Glaucomys sabrinus</i> )	28	40.00	3416	39.29	14	20.29	1708	22.16
Pocket Gopher ( <i>Thomomys bottae</i> )	9	12.86	990	11.38	3	4.35	330	4.28
Broad-handed Mole ( <i>Scapanus latimanus</i> )	2	2.86	110	1.26	4	5.80	220	2.85
Long-tailed Meadow Mouse ( <i>Microtus longicaudus</i> )	1	1.43	37	0.43	2	2.90	74	0.96
Deer Mouse ( <i>Peromyscus maniculatus</i> )	1	1.43	17	0.19	11	15.49	187	2.43
California Myotis ( <i>Myotis californicus</i> )	1	1.43	5	0.06	—	—	—	— <sup>a</sup>
<b>Birds</b>								
Steller's Jay ( <i>Cyanocitta stelleri</i> )	10	14.29	1070	12.31	9	13.04	963	12.49
<b>Insects</b>	7	10.00	21	0.24	7	10.14	21	0.27
<b>Total</b>	70	100.0	8695	100.0	69	100.0	7708	100.0

<sup>a</sup> Prey species not found within diet.

ing and nonbreeding pairs, further analyses were applied only to large and small mammals.

Relative proportion of large mammal prey was significantly greater ( $Z = 2.63$ ,  $P < 0.01$ ), while relative proportion of small mammal prey was significantly less ( $Z = 3.11$ ,  $P < 0.01$ ) within the diet of breeding pairs than nonbreeding pairs. Further, relative proportion of large mammal biomass was significantly greater ( $Z = 14.09$ ,  $P < 0.01$ ), while the relative proportion of small mammal biomass was significantly less ( $Z = 14.14$ ,  $P < 0.01$ ) within the diet of breeding pairs than nonbreeding pairs.

#### DISCUSSION

As with Northern Spotted Owls (Solis 1983; Forsman et al. 1984; Barrows 1985), woodrats and Northern Flying Squirrels were important prey for California Spotted Owls in the Sierra Nevada. Woodrats (37.4%) and Northern Flying Squirrels (31.2%) composed most of the biomass within the diet of California Spotted Owls. Similar to Barrows (1985), our results indicated that successful breeding was correlated to the greater relative proportion of large mammal prey within the diet of California Spotted Owls. Further, our results indicated that the diet of breeding California Spotted Owl pairs had

fewer and less biomass of small mammal prey than nonbreeding pairs.

Laymon's (1985) and our data (Table 1) indicated that more birds were present within the diet of California Spotted Owls than reported for either Northern Spotted Owls (Barrows 1980; Solis 1983; Forsman et al. 1984) or Mexican Spotted Owls (*Strix occidentalis lucida*) (Ganey 1988). Birds accounted for 13.7% of prey composition and 12.4% of prey biomass within the diet of California Spotted Owls.

Steller's Jay (*Cyanocitta stelleri*) was the only bird species found within the diet of owls we studied. However, we may have underestimated the number of birds within the diets because we counted only bills. Remains of large prey, such as jays, can occur in several pellets (Forsman et al. 1984).

Insect occurrence for diets of spotted owls seems to be highly variable. Forsman et al. (1984) reported that insect occurrence for diets of Northern Spotted Owls in Oregon ranged from 2.3–32.5% annually and from 1.8–62.3% seasonally. Insect occurrences for diets of Northern Spotted Owls in California were 6.8% (Solis 1983), 12% and 13% (Barrows 1980; 1987, respectively). For insect occurrence within California Spotted Owl diets, we found 10.1% (Table 1) for owls in the central Sierra Nevada and

Barrows (1980) reported 17.6% for owls in southern California. Ganey (1988) reported insect occurrence for diets of Mexican Spotted Owls in Arizona was 5.3%. Therefore we suggest that spotted owls may forage opportunistically on insects.

Relative abundances of prey species within spotted owl territories was not estimated. Therefore, we cannot infer whether our results indicate a preferential selection of large mammal prey by breeding pairs or greater availability of large mammal prey within territories of breeding pairs.

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**Department of Wildlife, Humboldt State University, Arcata, CA 95521.**

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## FOOD HABITS OF TURKEY VULTURES IN WEST TEXAS

CHRISTOS THOMAIDES, RAUL VALDEZ, WILLIAM H. REID AND RALPH J. RAITT

**ABSTRACT.**—Ninety-one casting pellets of the Turkey Vulture (*Cathartes aura*) were collected from a roost in El Paso County, Texas, in June 1980 and June–September 1982. Analysis revealed mammalian hair and small bone fragments in 100% of the pellets, reptilian scutes and small bones in 83.5%, and avian feathers and small bone fragments in 44%. Presence of arthropod remains and vegetative matter was minimal. Hair of leporids and mustelids was most common. Diversity and distribution of taxa constituting food items show Turkey Vultures to be opportunistic scavengers covering a variety of local habitats.

Reports of food habits of the Turkey Vulture (*Cathartes aura*) have been either anecdotal (Green 1927; Kempton 1927; Hamilton 1941; Scott 1941) or focused on certain aspects of feeding behavior (Mueller and Burger 1967; Glading and Glading 1970; Jackson et al. 1978; Stewart 1978). Pellet casting was reported by Rea (1973) and Davis (1983). Paterson (1984) focused specifically on food items from pellets in Virginia. Yahner et al. (1986) and Coleman and Fraser (1987) provided pooled data from pellets of both Turkey and Black vultures (*Coragyps atratus*) in Pennsylvania and Maryland. This study focuses on food habits of Turkey Vultures in Trans-Pecos Texas. The species is the only common cathartid in the study area.

### STUDY SITE

The study site was situated in Hueco Tanks State Historical Park, located approximately 40 km northeast of El Paso, Texas. The park occupies an area of approximately 4.3 km<sup>2</sup> and is comprised mainly of 3 igneous rock cliffs. The park serves as a roosting site for about 100 vultures.

### MATERIALS AND METHODS

Ninety-one pellets were collected in June 1980 and June–September 1982. Pellets were weighed and length in mm recorded. Non-hair matter was removed first and weighed.

Hair matter was immersed in CCl<sub>4</sub> to remove oils and allowed to air dry on a metal tray. Hairs were mounted on glass slides using clear double-coated tape and covered with a coverslip. A minimum of 100 hairs were analyzed from each pellet. Medullary configuration was the primary criterion for hair identification. Hair samples were identified by the use of keys provided by Mayer (1952), Stains (1958) and Moore et al. (1974), and comparison with hair reference samples obtained from the departmental collection.

### RESULTS

Most pellets resembled a loose mass of hairs and other matter; others were more compact resembling accipitrid pellets. Mean pellet length was 38 mm

(range 10–92 mm) and mean weight was 1.36 g (range 0.12–6.49 g).

Mammalian remains were present in all pellets. Mammalian skeletal remains (bone fragments and rodent teeth) were present in 18 pellets (20%). Reptilian remains were found in 76 pellets (83.5%) and consisted of scutes and bones. Avian remains were present in 40 pellets (44%) and included small fragments of contour feathers, whole semiplume and down feathers and bone fragments (Table 1). A small amount of arthropod remains, mostly from insects, were present in 11 pellets (12%) and consisted of parts of exoskeletons. Vegetative matter was negligible. Non-hair matter constituted a mean of 9% of pellet weight (range 0.4–79.4%).

### DISCUSSION

Turkey Vultures in this area primarily consume small to medium-sized carrion. Stewart (1978) and Coleman and Fraser (1987) reported that where Turkey and Black Vultures coexist, the former confine themselves to smaller carrion, while the latter fed on larger carcasses. Turkey Vultures in the El Paso area also feed on larger carrion (Table 1). Davis (1979) reported that in west Texas carcasses of wild and domestic ungulates accounted for 15–24% of the food consumed by Turkey Vultures observed in the area. Paterson (1984) and Yahner et al. (1986) reported high frequencies of ungulate hairs in vulture pellets. The fact that hairs of ungulates are rare in vulture pellets from Hueco Tanks may reflect the low availability of wild and domestic ungulates in the study area.

Presence of sorcid hairs is unusual considering their small size. Paterson (1984) also reported sorcid hairs and commented positively on the ability of Turkey Vultures to locate such minute sources of food. The presence of small mammals was also high

Table 1. Percent occurrence of taxa from animal food identified in 92 turkey vulture pellets.

TAXA <sup>1</sup>	% OCCUR- RENCE
Class Mammalia	
Family Leporidae	89.0
<i>Sylvilagus auduboni</i> (Desert Cottontail)	23.0
<i>Lepus californicus</i> (Blacktailed Jackrabbit)	22.0
Family Mustelidae	76.9
<i>Mustela frenata</i> (Longtail Weasel)	22.3
<i>Mephitis mephitis</i> (Striped Skunk)	37.3
<i>Taxidea taxus</i> (Badger)	26.3
<i>Spilogale gracilis</i> (Spotted Skunk)	9.9
<i>Conepatus mesoleucus</i> (Hognose Skunk)	3.3
Family Cricetidae	25.0
<i>Neotoma</i> spp. (Woodrat)	20.8
<i>Onychomys</i> spp. (Grasshopper Mice)	11.0
<i>Peromyscus</i> spp. (White-footed Mice)	8.8
<i>Reithrodontomys megalotis</i> (Western Harvest Mouse)	7.7
Family Sciuridae	24.0
<i>Eutamias</i> spp. (Chipmunks)	1.1
Family Heteromyidae	
<i>Dipodomys</i> spp. (Kangaroo Rats)	13.2
<i>Perognathus</i> spp. (Pocket Mice)	11.0
Family Cervidae	
<i>Odocoileus</i> spp. (Mule and White-tailed deer)	7.7
Family Muridae	
<i>Rattus rattus</i> (Black Rat)	9.9
<i>Rattus norvegicus</i> (Norway Rat)	5.5
<i>Rattus</i> spp. (Rats)	14.3
Family Geomyidae	
<i>Thomomys</i> spp. (Pocket Gophers)	8.8
Family Canidae	5.5
<i>Vulpes macrotis</i> (Kit Fox)	2.2
<i>Canis latrans</i> (Coyote)	2.2
<i>Urocyon cinereoargenteus</i> (Gray Fox)	1.1
Family Bovidae	
<i>Bos taurus</i> (Cattle)	7.7
Family Soricidae	
(Shrews)	1.1
Family Procyonidae	
<i>Bassariscus astutus</i> (Ringtail)	1.1
Class Aves	44.0
Order Passeriformes	
(Passerine birds—small)	2.2
Class Reptilia	
Suborder Lacertilia	
Family Iguanidae	
<i>Sceloporus</i> spp. (Spiny Lizards)	6.6

Table 1. Continued.

TAXA <sup>1</sup>	% OCCUR- RENCE
<i>Cnemidophorus</i> spp. (Whiptail Lizards)	9.9
<i>Phrynosoma cornutum</i> (Texas Horned Lizard)	2.2
Suborder Serpentes (small size)	3.3
Family Colubridae	45.0
<i>Arizona elegans</i> (Glossy Snake)	3.3

<sup>1</sup> Remains were identified to lowest category based on food item.

( $\leq 27\%$ ). Yahner et al. reported that small mammal hairs were present in 16% of pellets. Coleman and Fraser (1987) found presence of small mammals in only 5% of pellets.

Davis (1979) mentioned two occasions of Turkey Vultures feeding on rattlesnakes (*Crotalus* spp.). No remains from viperid snakes were found in pellets. Some lizards found in the pellets may have been contained in the stomachs of colubrid snakes consumed by vultures (Webb, pers. comm.).

Vegetative matter present in pellets seemed accidental and was attached to the outside of the pellet rather than contained within. Coleman and Fraser (1987) also considered vegetation to have been consumed accidentally, although present in 88% of the pellets. Davis (1983) and Paterson (1984) reported high incidence of vegetative remains in pellets of Turkey Vultures. Presence of arthropod remains in pellets was minimal, although Coleman and Fraser (1987) reported that Turkey Vultures actively fed on insect larvae.

Geographical distribution in the vicinity of the roost of the taxa represented in pellets, as well as the diversity of food items, indicates that Turkey Vultures are opportunistic scavengers covering a variety of local habitats. Vultures may forage as much as 74 km from the roost, as indicated by the presence of chipmunk (*Eutamias* spp.) hairs in pellets. The closest population of *Eutamias* occurs in Lincoln National Forest, New Mexico, approximately 74 km north of Hueco Tanks (Findley et al. 1975).

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**Department of Fishery and Wildlife, New Mexico State University, Las Cruces, NM 88003. Present address of first author: 84 Marasli St., GR-54249 Thessaloniki, GREECE. Address of third author: Department of Biology, University of Texas at El Paso, TX 79902.**

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## SHORT COMMUNICATIONS

### DETERMINING AGE AND SEX OF NESTLING GYRFALCONS

K. G. POOLE

Accurate aging of nestling birds is useful in determining breeding chronology so that informed management decisions can be made. Nestling age is also needed to estimate reproductive success using the Mayfield method (Mayfield 1975), which is useful in calculating a daily nest survival rate from all breeding attempts checked more than once during a breeding season. No growth data have been published that enable field workers to determine sex or estimate age ( $\pm 3$  d) of nestling Gyrfalcons (*Falco rusticolus*). Although sexually dimorphic in weight as adults (males = 62–68% of female weights on average [Cramp and Simmons 1980:360]), determining sex using weight of nestlings <4 wk old is unreliable, because 1) the possibility exists for asynchronous hatching (Poole and Bromley 1988), and 2) opposite-sex siblings are not always present for size comparison.

Estimating age by comparing nestlings to photographs of known-age chicks (Moritsch 1983) is too subjective to ensure accuracy to within a few days (Petersen and Thompson 1977; Bechard et al. 1985). Growth of primary remex feathers in raptors appears to be linear until shortly before maximum length is attained (Petersen and Thompson 1977; Ellis 1979; Newton 1979; Bortolotti 1984; Simmons 1984; Bechard et al. 1985). Length of the fourth primary remex has been used to estimate age of nestling Red-tailed Hawks (*Buteo jamaicensis*) to within  $\pm 2$  d (Bechard et al. 1985). Length of central rectrix feathers has been suggested as a means of estimating age of nestling Gyrfalcons (after feather emergence) in Iceland (Nielsen 1986), but growth data were not presented. In this paper I present weight and feather growth rates and suggest how these measurements can be used to determine sex and estimate age of wild, nestling Gyrfalcons.

Research was conducted on the Kilgavik study area in the Northwest Territories, Canada (68°10'N, 106°15'W). Details on vegetation and climate of the area are reported in Poole and Bromley (1988). Weights and feather measurements were obtained from 11 male and 9 female known-age nestling Gyrfalcons in 1985 (3 nests) and 1986 (4 nests). Most nestlings were found on their day of hatch, or were observed as pipping eggs and assumed to hatch the following day (Newton 1979). Hatch of 2 nestlings at one nest was determined from time-lapse film (Poole and Bromley 1988). Sex was ascertained subjectively late in the nestling period (mean age of last measurements of nestlings = 38 d; range 33–42 d) based on weight dimorphism (Nielsen 1986) and differences in wing chord and

tarsus length measurements among siblings and broods. All 20 nestlings fledged successfully.

Data were collected at irregular intervals of 2–7 d. Weights were obtained using a Pesola 300-g spring scale for younger nestlings (to nearest 1 g) and a 2000-g scale for larger chicks (to nearest 5 g). No allowance was made for crop contents. Feather measurements were taken using a plastic mm rule both from the right seventh primary remex (numbered distally from carpal joint) and from the right middle rectrix, from the point of insertion in the body (at the base of the follicle) to the feather tip ventrally along the straightened rachis. Nestlings were differentiated using felt pen marks on the head until 14 d of age when each was banded with numbered U.S. Fish and Wildlife Service aluminum leg bands. Visits to nests ended when chicks were about 40 d old and the chance of premature fledging and risk of injury was increased. Gyrfalcons typically fledge at 45–50 d of age (Cramp and Simmons 1980; Poole and Bromley 1988). Because of the small number of nestlings examined, all measurements were used to calculate regressions, even though data were not independent (see Bechard et al. 1985).

Weight gain of nestling Gyrfalcons (Fig. 1) followed a sigmoidal growth pattern typical in other raptors (Olen-dorff 1974; Ellis 1979; Newton 1979). During the period of rapid growth (6–27 d), males gained weight at about 50 g/d and females at about 59 g/d ( $F = 6.39$ ;  $df = 1,85$ ;  $P < 0.02$ ).

Regression coefficients of seventh primary remex length by age were slightly greater than those from middle rectrix length by age for both sexes (males: remex  $r = 0.986$ , rectrix  $r = 0.979$ ; females: remex  $r = 0.986$ , rectrix  $r = 0.968$ ). Rectrices were often tattered because of abrasion from nest substrate, therefore age estimation was calculated using primary remex length only. No significant difference in feather growth (dependent variable) with age occurred between sexes (ANOVA,  $P > 0.75$ ), and data for males and females were combined. Seventh primary remiges emerged when chicks were about 11 d old (Fig. 2). Feather growth was linear over the period examined but probably decreased closer to fledging (likely beginning about 40–42 d of age). Using inverse prediction (Sokal and Rohlf 1981:497) from a linear relationship (Bechard et al. 1985), nestling age (NA) for young >11 d old can be determined from seventh primary remex length as

$$NA = 0.15PL + 11.7 \quad (1)$$

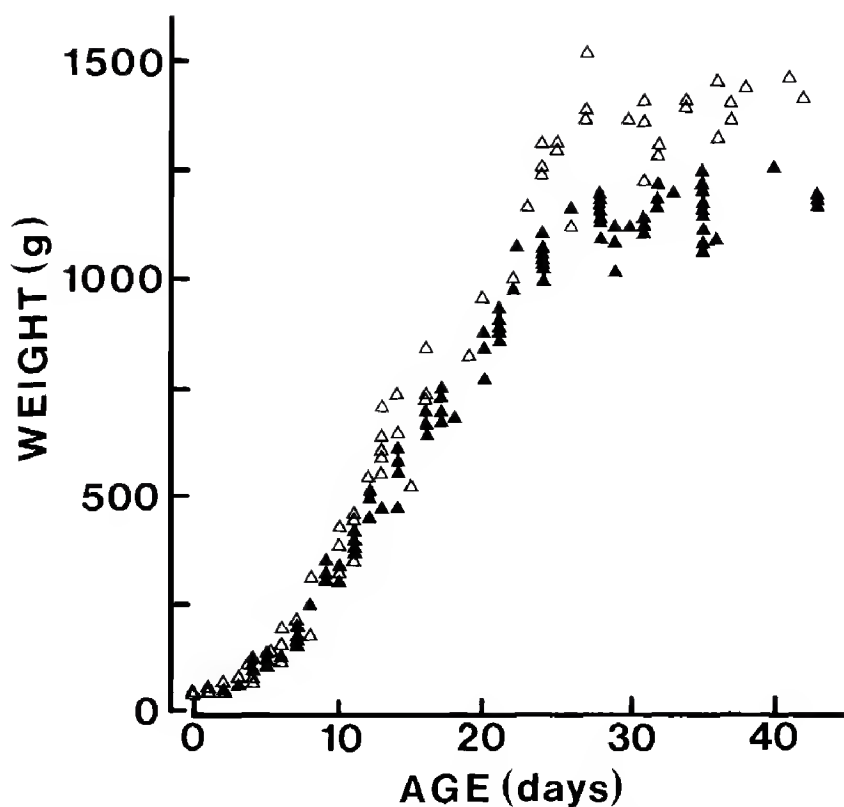


Figure 1. Relationship between age and weight of male (closed triangles) and female (open triangles) nestling Gyrfalcons. Data points include repeated observations on individuals (males  $N = 11$ , females  $N = 9$ ).

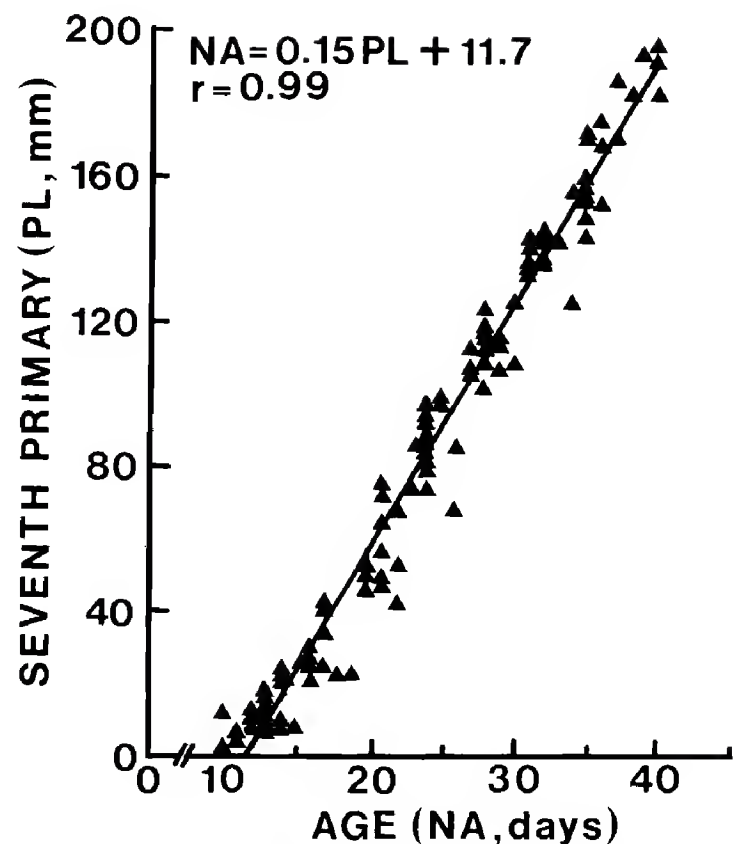


Figure 2. Relationship between nestling age (NA) and length of seventh primary remex (PL) of Gyrfalcons. Data points include repeated observations on individuals ( $N = 20$ ).

( $r = 0.99$ ,  $P < 0.001$ ), where NA is nestling age (d) and PL is seventh primary remex length (mm). All data points ( $N = 108$ ) from the 20 nestlings, except for 4 points from the same nestling, were within 3 d of predicted age, and most points (88%) were within 2 d (Fig. 2). The 95% confidence limits for age estimates using the above equation were  $\pm 3$  d (Snedecor and Cochran 1967:159–160).

In nestlings  $\leq 11$  d old, prior to emergence of primary remiges, age is best estimated by weight by the equation

$$NA = -0.000069(WT)^2 + 0.057(WT) - 1.2 \quad (2)$$

where NA is nestling age (d) and WT is nestling weight (g). All points used to determine this equation (age  $\leq 11$  d,  $N = 50$ ) were within 2 d of predicted age.

A combination of weight and seventh primary remex length measurements can be used to determine sex of nestlings  $> 11$  d old. As a result of similar primary growth between sexes but more rapid weight gain in females, a plot of seventh primary remex length against weight produced a range of points generally separate by sex (Fig. 3). A plot of seventh primary length versus weight from a nestling of unknown sex should produce a point on one side or the other of the curved line in Fig. 3.

Estimation of age or sex can be biased by several factors. Weight curves are subject to daily or seasonal variation in food availability, such that starved females could be classed as large males (Fig. 3). However, starvation appears to

have a minimal effect on growth of remex feathers (Petersen and Thompson 1977). Although growth of remiges in young Gyrfalcons appears linear until late in the nestling period, limited evidence suggests that growth rate of remiges may fluctuate to some extent (D. G. Roseneau, pers. comm.).

Larger sample sizes may increase the accuracy of predictions, and use of nonindependent data in my analyses may have underestimated variation. However, I believe techniques presented here are adequate to estimate age and determine sex of nestling Gyrfalcons up to about 40 d of age in the central Northwest Territories. Because size differences in Gyrfalcons are minor throughout their range (Cramp and Simmons 1980), these techniques may apply to other regions as well. Additional tests would determine the applicability of these equations to Gyrfalcons elsewhere.

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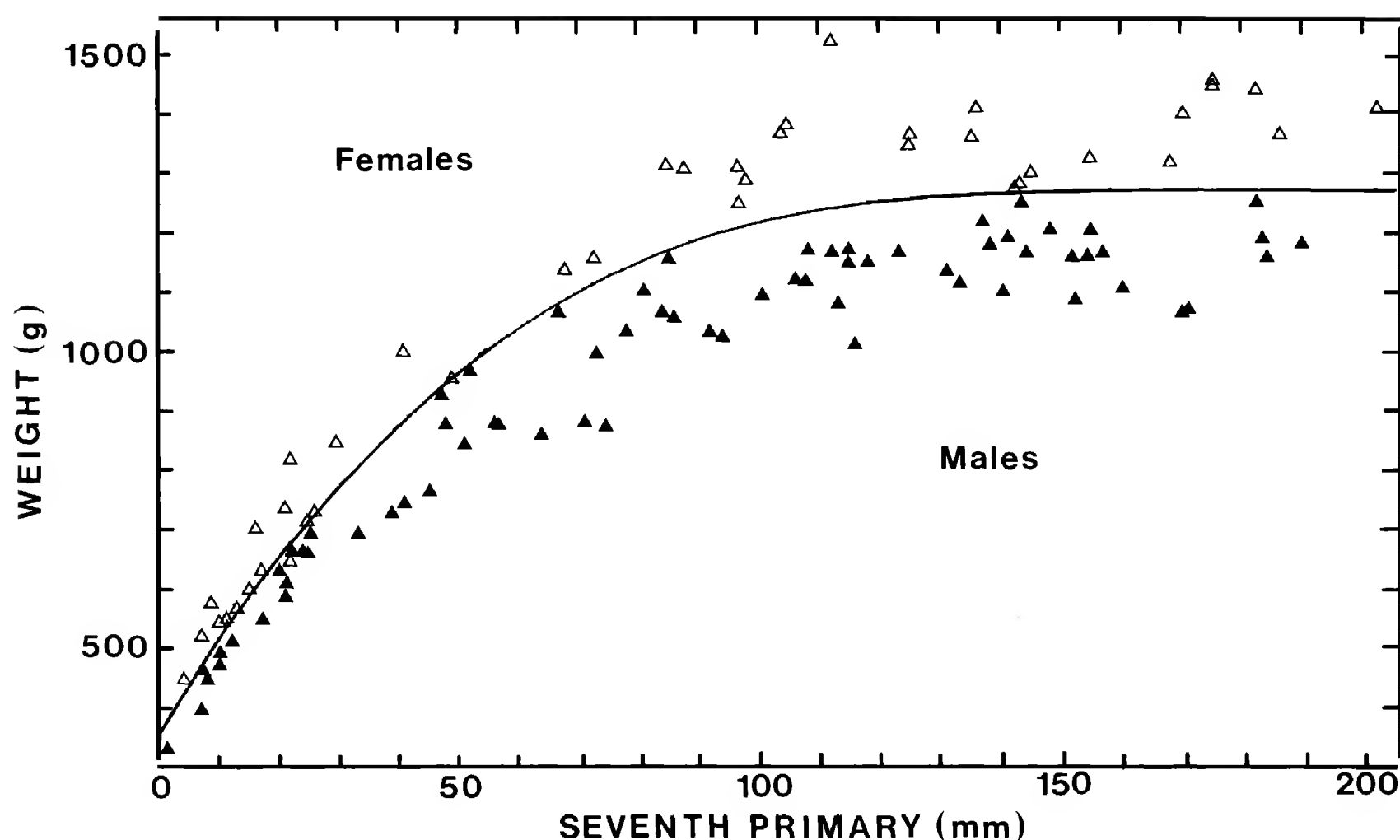


Figure 3. Relationship between length of seventh primary remex and weight of male (closed triangles) and female (open triangles) nestling Gyrfalcons. Data points include repeated observations on individuals (males  $N = 11$ , females  $N = 9$ ). Dividing line placed by eye.

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- Wildlife Management Division, N.W.T. Department of Renewable Resources, Yellowknife, Northwest Territories X1A 2L9, CANADA.**

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## OBSERVATIONS ON COOPERATIVE MOBBING OF A BALD EAGLE

ROBERT CHARLES HUMPHREY

Mobbing is a well known avian behavioral response and is described as a "demonstration made by a bird against a potential or supposed enemy belonging to another and more powerful species: it is initiated by the member of the weaker species, and is not a reaction to an attack upon the person, mate, nest, eggs or young." (Hartley, *Symp. Soc. Exp. Biol.* 4:313-336, 1950). Leahy (The birdwatcher's companion. McGraw-Hill, Ryerson Ltd. Toronto, 1982) described it as "The harassing of a predatory species, usually by a mixed flock of smaller passerines. . . . a collective response to a common danger." Mobbing responses are normally directed at predatory birds, particularly hawks and owls passively intruding into territorial or roosting areas of smaller birds (Wilson, E. O., *Sociobiology*. Harvard University Press, Cambridge, Massachusetts, 1975), or when foraging passerines encounter roosting raptors. Altmann (*Condor* 58:241-253, 1956) stated, "Birds will often respond "by contagion" to the reactions of other birds . . . and are the basis for large aggregations that sometimes form around predators." Part of the reason for this contagion is the similarity in duration and frequency of mobbing calls by different bird species (Marler, P. R. in P. R. Bell, ed., *Darwin's biological work: some aspects reconsidered*, pp. 150-206, 1959). In general mobbing is considered a mono-specific, or mixed flocks of small passerines mobbing larger birds, (Corvids), or small raptors such as Screech Owls (*Otus asio*); or larger birds such as jays and crows (*Corvidae*) mobbing raptors. Raptors, in interspecific concert, do not commonly mob larger birds of prey. In this note I report an instance of raptors cooperatively mobbing a larger raptor.

On 9 May 1985 at approximately 1100 H (EST) I observed cooperative mobbing of a Bald Eagle (*Haliaeetus leucocephalus*) at Monomoy National Wildlife Refuge, Chatham, Massachusetts. There was little wind, no cloud cover, and the temperature was approximately 20°C. A juvenile Peregrine Falcon (*Falco peregrinus*) flew across the field of view of a 20× spotting scope to an area about 400 m to the north where over 1000 Herring (*Larus argentatus*) and Great Black-backed Gulls (*Larus marinus*) were flying and giving distress calls. A juvenile Bald Eagle, soaring approximately 30 m above the ground, was in the center of the flock of birds. The falcon, 5 Common Crows (*Corvus brachyrhynchos*), a female Northern Harrier (*Circus cyaneus*), 2 Short-eared Owls (*Asio flammeus*) and no fewer than 50 gulls and 75 Red-winged Blackbirds (*Agelaius phoeniceus*) were mobbing the eagle.

It was obvious that there was a distinct, species-specific

stratification of distance between the mobbing birds and the eagle that was maintained until the eagle landed (1120 H EST). The conspecifics altered positions and distances relative to one another but maintained approximate distances from and directed their aggressions (alarm calls, mock attacks) toward the eagle. The Peregrine made several stoops at the eagle. I then lost sight of the falcon and did not see it again. Of the mobbing birds the Peregrine came the closest, probably within 1 m from the eagle. The crows approached the eagle to within 2-3 m and remained within 5 m of the eagle for the entire episode. The harrier although not actually directly harassing the eagle was integrated in the mob and maintained a distance of 5-10 m from the eagle. The owls never approached closer than 9 m from the eagle, while the blackbirds flew in and out of the various ranges of the larger birds. Most of the gulls stayed outside of 20 m from the eagle, although some approached as close as the owls. All of the birds were part of a large aggregation responding to the presence of the eagle.

Of further interest is that not only were heterospecific raptors (harriers, owls, falcons) collectively mobbing the eagle, but also that a variety of non-raptorial birds overcame or dismissed their usual conditioned response to familiar avian predators to participate in the mobbing (Wilson, E.O., *Sociobiology*. Harvard University Press, Cambridge, Massachusetts, 1975). In this same area in the past, I have observed blackbirds mobbing crows and harriers, crows mobbing harriers and owls, and gulls mobbing or harassing harriers, owls and Peregrines. In each case the mobs were mono-specific. Whether the observed cooperative mobbing was a contagious response to a large concentration of gulls in the aggregation as Altmann (1956) suggests, a stronger stimulus by the eagle over the usual stimulus toward smaller or "less dangerous" predators, or a combination of both could not be determined. Unfamiliarity of local birds to such a large avian predator could also be a contributing factor.

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**Monomoy National Wildlife Refuge, Chatham, Massachusetts 02633. Present address: 198 Topsfield Rd., Wenham, Massachusetts 01984.**

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## ACTIVITIES OF A MIGRANT MERLIN DURING AN ISLAND STOPOVER

ARLO RAIM, WILLIAM W. COCHRAN AND ROGER D. APPLIGATE

Activities of a radio-tagged Merlin (*Falco columbarius*), which was trapped and identified as an adult female by George Allez and Daniel D. Berger, were observed from 10–16 April 1977 on Loggerhead Key, a 20 ha island in the Dry Tortugas (Fig. 1). The island is located in the Gulf of Mexico, 126 km west of Key West, Florida. Habitats consisted of 1) surrounding gulf waters, 2) open coral beach, 3) dense stands of Australian pine (*Casuarina equisetifolia*), 4) a community dominated by *Opuntia* spp. and century plant (*Agave americana*), 5) a grass association dominated by *Uniola* spp., and 6) areas adjacent to the lighthouse and buildings, planted in coconut palms (*Cocos nucifera*). Many birds of prey pause at Loggerhead Key during spring migration according to Ward (1975), who states, “a research team consisting of me, Mr. William S. Clark, Mr. William S. Seegar, and Mr. Edward B. Prescott, visited Loggerhead Key in shifts from 9 through 17 April 1974. Birds of prey observed during this period included 5 Peregrine Falcons, 63 Merlins, 48 kestrels, 4 Sharp-shinned Hawks, 3 Broad-winged Hawks, and 12 Ospreys.”

An adult female Merlin trapped on 9 April 1977 at 1600 H (EST), had a U.S. Fish and Wildlife Service band applied and a 3.3-gram radio transmitter attached using the tail feather attachment method described by Cochran (1975). The Merlin was released on 10 April at 0715 H (EST) with one of us (AR) thereafter radio-tracking the bird on foot continuously during the daylight hours through 16 April to allow for visual observation during 80% of that time (75.6 hr). The Merlin migrated north at 0733 H on 17 April. The bird stayed on or near the island during the 7 d except for 73 min on 15 April when it flew east 4 km to Garden and Bush keys at 0937 H (EST).

Tracking was done cautiously to avoid disturbing the Merlin; however, 9 of 277 observed flights (Fig. 2a) may have been caused by the tracker (6 flights) or by other people with dogs (3 flights). In these nine cases the bird was on the ground or within 5 m of the ground with a cuckoo prey when flushed. Although the tracker often came equally close to the bird when it was perched in a tree, the Merlin did not flush in those instances.

Over 7 d of observation, the Merlin's time in flight averaged 5.7% (range 1.9%–10.8%) of daylight (the 808 min between morning and evening civil twilight). This is similar to 6% reported for migrating Peregrines (*Falco peregrinus*) (Cochran 1975) and 6.5 to 7.1% for winter Goshawks (*Accipiter gentilis*) (Widen 1984). The reduced

flight of the Merlin on 10 April (Fig. 2a) may have been related to its having been held overnight. Upon release the Merlin flew to an Australian pine and remained until 1230 H. On 13 and 14 April, when Yellow-billed Cuckoos (*Coccyzus americanus*) were captured early, flight time and number of flights were markedly less than on days when lighter prey were captured (Fig. 2).

Four of 20 (20%) observed capture attempts were successful. Eight other prey observations (of the 12 documented, Fig. 2b) were the result of unobserved capture attempts (behind vegetation or buildings, or out over the water). The 20% success rate is within the range of hunting success reported elsewhere: 25% (Toland 1986), 12.8% (Page and Whitacre 1975), 5% (Rudebeck 1951), 22.5% (Buchanan et al. 1988).

Feeding (eating, standing with prey, or bill wiping) time averaged 7.0% of daylight (range 0–21.6%). The least feeding was observed the first two days after release (0% and 0.7%). Feeding was shorter (4.0% of daylight) on days when lighter prey were captured and longer (14.6% of daylight) on days when heavier prey (Yellow-billed Cuckoos) were captured. The extra feeding time on large prey was largely a result of the time spent holding the prey between bouts of feeding. Cuckoos were held on or near the ground until partially consumed or until the Merlin was flushed. Light and medium-sized prey were always carried to an elevated perch where they were immediately consumed. One of the cuckoos was cached in a tree and consumed during two visits. Caching has been noted previously for Merlins (Sperber and Sperber 1962; Oliphant and Thompson 1976).

Preening averaged 3.0% of the daylight period (range 0.14–8.8%), including time spent manipulating the band (0.4% of daylight) and radio transmitter (0.6% of daylight). During the first 5¼ hr after release, while perching in the same tree, 10.1% of her time was spent grooming (4.1% preening, 4.1% manipulating the band and 1.9% preening the transmitter). We include the bird's response to the presence of the band and transmitter as preening time because the bird appeared to be attempting to preen away these objects and because all band and transmitter manipulation occurred while preening. The amount of time spent in manipulating the band and transmitter suggest the behavioral effect of these study techniques is probably small. The decreased initial flight and feeding were probably due to handling and being held overnight.

Seven prey species identified (Fig. 2b) were among those

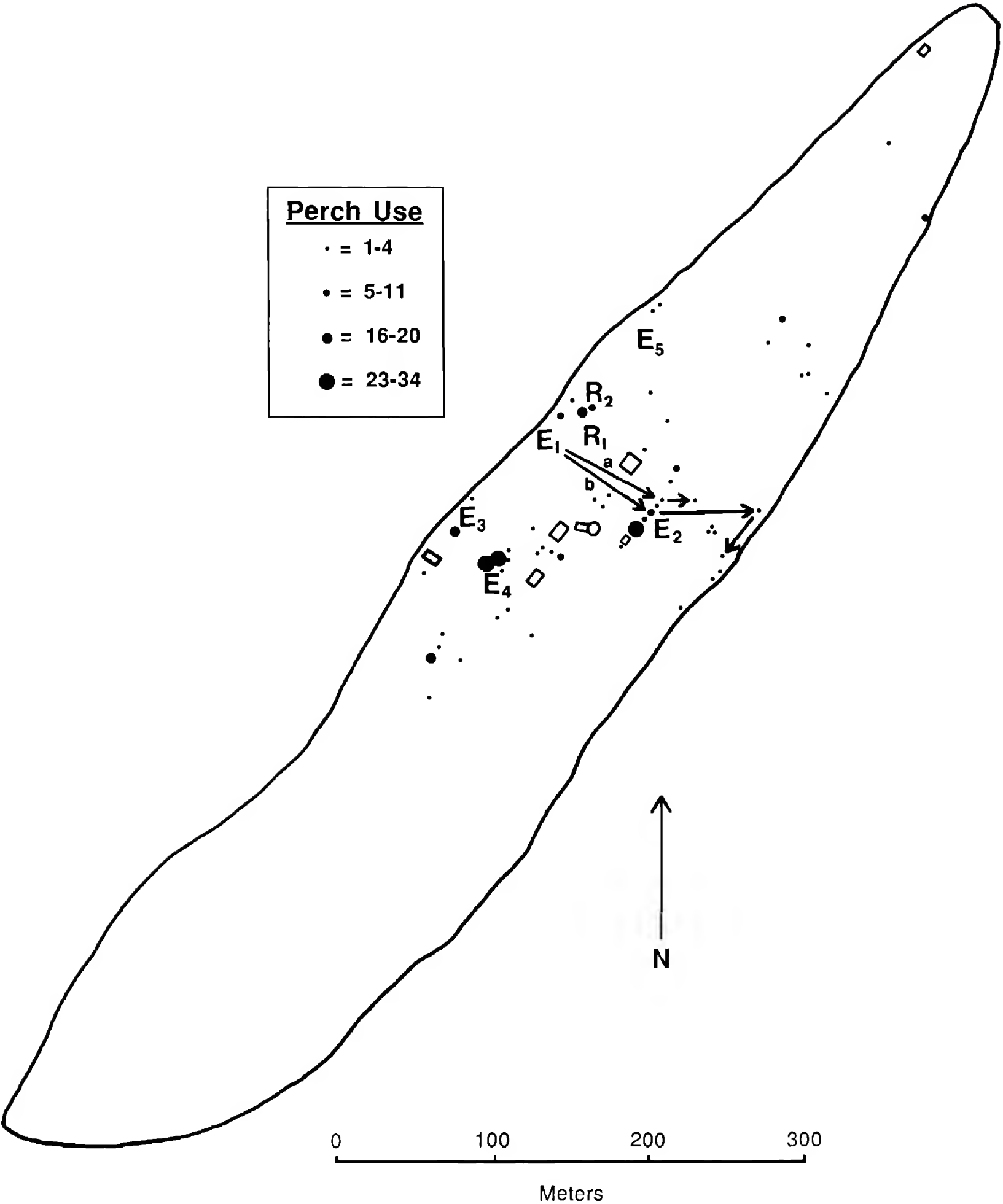


Figure 1. Perching (dots), feeding (E), and roosting (R) sites of a female Merlin on Loggerhead Key during an April migratory stopover. Open rectangles and circle (light house) are buildings. Size of perch symbols indicates frequency of use. Roosting site R1 was used 10–13 April and R2 14–16 April. Feeding site E1 was used on 11, 13 and 14 April; E2 on 12 and 14 April; E3 on 12, 13, 15 and 16 April; E4 on 15 April; E5 on 16 April. Arrows indicate the consecutive feeding sites used while feeding on a large prey item on 13 April (a) and 14 April (b).



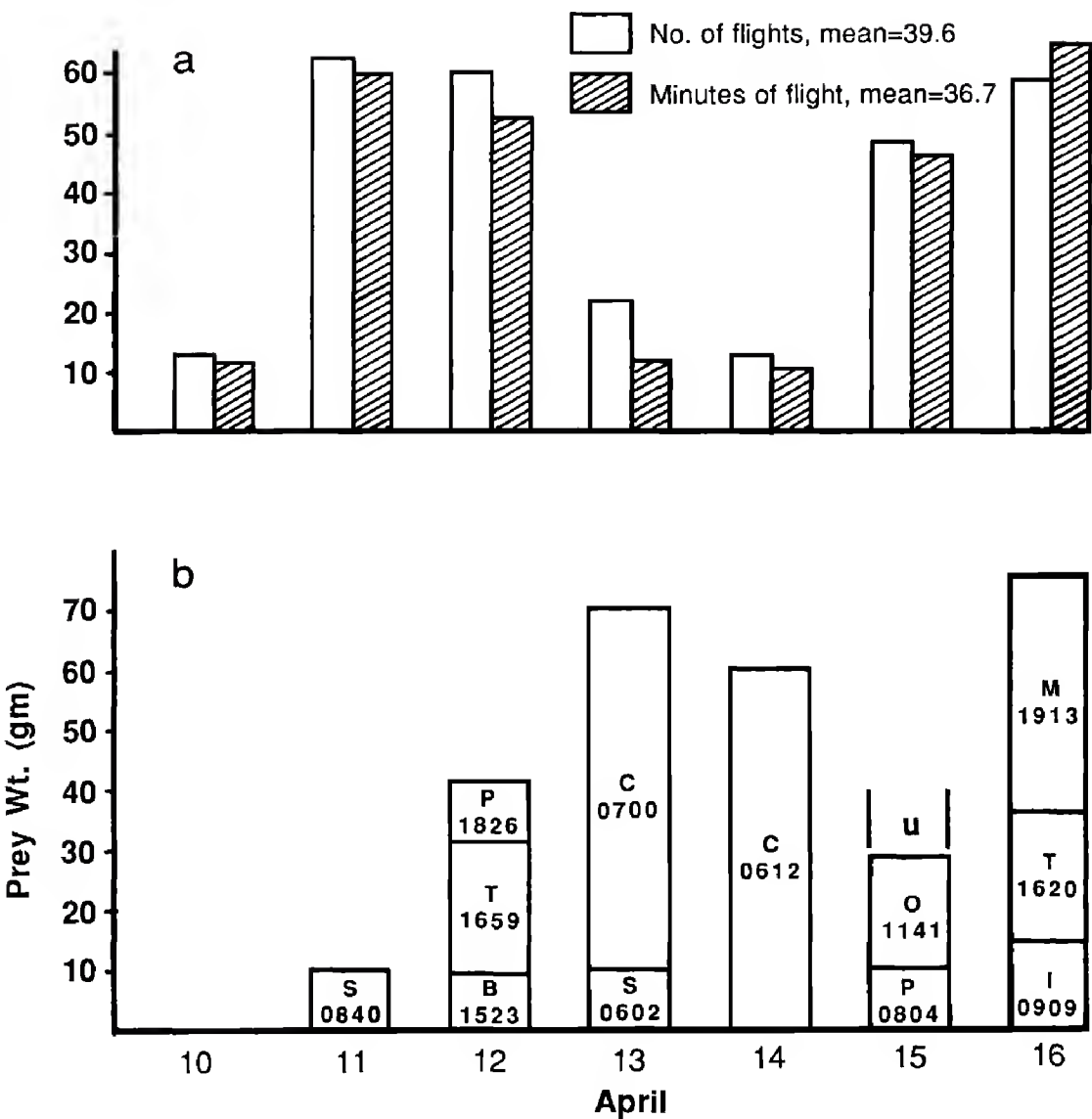


Figure 2. Daily breakdown of Merlin a. flight activity and b. prey weight, species and time taken. S = small bird (approx. 10 grams), B = Black-throated blue warbler (*Dendroica caerulescens*), T = Tree swallow (*Iridoprocne bicolor*), P = Palm warbler (*D. palmarum*), C = Yellow-billed cuckoo (*Coccyzus americanus*), O = Ovenbird (*Seiurus aurocapillus*), I = Indigo bunting (*Passerina cyanea*), M = medium-sized bird (approx. 40 grams), U = unknown prey taken in Garden or Bush Key area, if any. Weights are from Clench and Leberman (1978).

reported to be common Merlin prey (Bent 1938; Breckenridge and Errington 1938; Craighead and Craighead 1940; Oliphant and McTaggart 1977; Hodson 1978; Page and Whitacre 1975; Becker 1985). Most of these prey were among the commonest prey observed in the areas in which the Merlin was observed to hunt (A. Raim, pers. obs.).

Most activities took place in the central semi-open part of the island (Fig. 1) where there were numerous scattered live and dead Australian pines, coconut palms and *Agava* stalks. Less than 15% of daylight was spent in the open scrub vegetation in the south and the denser Australian pine in the north and northwest parts of the island. The Merlin perched in many different locations during the day; some perch sites were used repeatedly. As indicated by monitored radio signals, the Merlin also perched and made several flights while in the vicinity of Garden and Bush Keys.

Two trees were used as night roosts. Roosting from 10 through 13 April was in a coconut palm (Fig. 1: R1) and from 14 through 16 April, in an Australian pine (Fig. 1: R2). On the two mornings when the Merlin was found perched exactly where she had roosted the night before, she left 12 and 18 min before sunrise. On the other four days she had already left the roost by the time observation began (range 12 min before sunrise to 8 min after sunrise). The time that she went to roost averaged 20.5 min (range 11–27 min) after sunset on 4 evenings and were between 20 and 30 min after sunset on three occasions when the exact minute she arrived at the roost tree could not be determined.

On thirteen occasions the Merlin was observed near other raptors. In five instances the radio-tagged Merlin chased other Merlins; in three instances it took off and flew with passing Merlins for short distances before returning to its perch. Three other times it ate or perched

in a tree occupied by another Merlin, with no interaction observed even when it flew and then returned to a perch 3 m from a male Merlin. The Merlin also stooped on a Northern Harrier (*Circus cyaneus*) and on another unidentified raptor.

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D. D. Berger and G. Allez trapped the Merlin and assisted with observations. K. Robertson assisted with plant identification. This study was supported in part by U.S. Army contract from F. P. Ward. W. Edwards and W. Iko critically reviewed the manuscript.

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**Illinois Natural History Survey, Section of Wildlife Research, 607 East Peabody Drive, Champaign, IL 61820. Present address of third author: Department of Inland Fisheries & Wildlife, Wildlife Resource Assessment Team, Wildlife Division, P.O. Box 1298, Bangor, ME 04401-1298.**

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### BALD EAGLE DIES FROM ENTANGLEMENT IN FISH NET

JAMES W. WATSON

Discarded fishing line is a reported source of mortality to birds (Bartel, *N. Am. Bird Band.* 9:8, 1984) including raptors (Knight, Skriletz and Ryan, *Raptor Res.* 14:40, 1980; L. Young, Snake River Birds of Prey Research Project, pers. comm.). Fish nets also kill non-target wildlife including fish, marine mammals, reptiles and seabirds (Stone, NOAA Tech. Memo. NOAA-TM-NMFS-SWR-012, 1986). There is apparently no reference in the literature to raptor deaths from net entanglement.

On 20 April 1988, while collecting information on Bald Eagle (*Haliaeetus leucocephalus*) nest parameters near Lummi Bay in northwestern Washington, I came upon the badly decomposed carcass of a juvenile (approx. 9 wk old) eagle. The bird was evidently 1 of 2 observed in the nest in 1987. A closer investigation revealed that the eaglet was hanging by a 3 m × 0.5 m piece of 12 cm mesh monofilament fish net. The bird's head had passed through 2 of the gillnet meshes which were taut around the neck.

The nest was suspended in branches 3 m above the ground and held by nest sticks that were entangled in the net. Also entangled in the net was part of a steelhead (*Salmo gairdneri*) carcass and an unidentified bone. Evidence suggests that an adult eagle carried the entangled fish and net to the nest. Death to the eaglet resulted from strangulation and the 18 m fall from the nest.

This type of monofilament gillnet is commonly used by local steelhead fishermen. Gillnet fishing is increasing in the near-shore waters of Puget Sound and the Washington Coast (L. Clockin, Wash. Dept. of Fisheries, pers. comm.) where the majority of nesting and wintering eagles forage in the state. Although the population impacts from net

entanglement are unknown, this observation is significant because it documents that such nets can be a secondary source of mortality to Bald Eagles.

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## FOOD HABITS OF RED-TAILED HAWKS IN BOULDER COUNTY, COLORADO

DANIEL T. BLUMSTEIN

The Red-tailed Hawk (*Buteo jamaicensis*) is a common raptor in Colorado, yet nothing is known about its food habits there. The objective of this study was to qualitatively document nesting season food-habits of Red-tailed Hawks in Boulder County, Colorado. Boulder County is located on the eastern slope of the Front Range of the Rocky Mountains in north central Colorado. The county contains 5 major ecosystem types defined along an altitudinal gradient: Plains Grassland,  $\leq 1707$  m; Lower Montane Forest, 1829-2348 m; Upper Montane Forest, 2439-2744 m; Subalpine Forest, 2835-3354 m; and Alpine Tundra,  $\geq 3445$  m (Marr 1964).

Nests were located early in 1985 by visiting areas where Red-tailed Hawks and their nests were historically known to occur. After a nest fledged young or was abandoned, pellets and other prey remains (e.g., carcasses, body parts, etc.) found in its "white-wash" zone were collected during a 1 hr search. One nest tree was climbed and pellets and other remains were removed. Skulls and other identifiable body parts were identified whenever found. From nests having  $\leq 20$  pellets, all pellets were analyzed for mammalian and avian prey; 20 randomly selected pellets were analyzed from nests with  $> 20$  pellets. Five percent of the pellets that contained hair were re-analyzed to obtain a measure of precision ( $N$  consistently reidentified/ $N$  reidentified); 82% of the prey items in these were re-identified consistently. No attempts were made to identify scales or chitinous remains in this study despite their presence in pellets.

Ten nests were located (including 1 nest used in 1984

but not in 1985) in 3 ecosystem types (Plains Grassland, 6 nests; Lower Montane Forest, 2 nests; Upper Montane Forest, 1 nest) and 1 nest in the ecotone between Plains Grassland and Lower Montane Forest. Pellets and remains were collected beneath 7 nests and within 1 nest. Of 380 pellets collected from 8 of the nests (range 2-147), 112 (29%) were analyzed for content. Pellets from all habitats with nests were represented in the analysis.

Twenty-six mammalian and 6 avian species were identified, including 6 species that, to my knowledge, had previously not been reported to be consumed by Red-tailed Hawks (Table 1). Prey species were those expected to be found near respective nests based on known mammalian and avian distributions in Colorado (Armstrong 1972; Kingery and Graul 1978). Hawks from Plains Grassland consumed 17 different species (14 mammals, 3 birds), ecotone hawks, 7 species (4 mammals, 3 birds), Lower Montane Forest hawks, 12 species (11 mammals, 1 bird), and Upper Montane Forest hawks, 9 species (8 mammals, 1 bird). However, these discrepancies may be an artifact of the numbers of nests studied in each ecosystem. Preferences of individual hawks and availability and vulnerability of prey around a given nest influence what individual Red-tailed Hawks consume (Errington and Breckenridge 1938; Beebe 1974; Adamcik et al. 1979).

#### ACKNOWLEDGMENTS

I thank D. M. Armstrong for advice, criticism, and encouragement while conducting this project. M. Figgs, S. Jones, N. Lederer, and many members of the Boulder



Table 1. Mammalian<sup>a</sup> and avian<sup>b</sup> species consumed by Red-tailed Hawks<sup>c,d</sup> in Boulder County, Colorado.<sup>e</sup> Species marked with an asterisk had never previously been reported to be consumed by Red-tailed Hawks.<sup>f</sup>

SPECIES	HABITAT	N NESTS
<b>Mammals</b>		
Unidentified Shrews, <i>Sorex</i> spp.	UM	1
Black-tailed Jackrabbit, <i>Lepus californicus</i>	PG	1
Pika, <i>Ochotona princeps</i> *	LM, UM	2
Desert Cottontail, <i>Sylvilagus audubonii</i> <sup>c</sup>	PG	1
Nuttall's Cottontail, <i>Sylvilagus nuttallii</i>	PG	2
Unidentified rabbits, <i>Sylvilagus</i> spp.	PG	2
Beaver, <i>Castor canadensis</i> *	LM, UM	2
Black-tailed Prairie Dog, <i>Cynomys ludovicianus</i>	PG	3
Plains Pocket Gopher, <i>Geomys bursarius</i> *	PG	3
Yellow-bellied Marmot, <i>Marmota flaviventris</i>	E, LM, UM	3
Long-tailed Vole, <i>Microtus longicaudus</i> * <sup>c</sup>	LM	1
Prairie Vole, <i>Microtus ochrogaster</i> <sup>c</sup>	PG	2
Meadow Vole, <i>Microtus pennsylvanicus</i>	PG, E, LM, UM	6
Unidentified voles, <i>Microtus</i> spp.	PG, UM	3
Muskrat, <i>Ondatra zibethicus</i>	PG	2
Deer Mouse, <i>Peromyscus maniculatus</i>	PG	3
Unidentified mice, <i>Peromyscus</i> spp.	PG	1
Western Harvest Mouse, <i>Reithrodontomys megalotis</i>	PG	1
Plains Harvest Mouse, <i>Reithrodontomys montanus</i> *	PG	1
Abert's Squirrel, <i>Sciurus aberti</i>	E, LM	2
Fox Squirrel, <i>Sciurus niger</i>	PG	1
Unidentified squirrels, <i>Sciurus</i> spp.	E	1
Golden-mantled Ground Squirrel, <i>Spermophilus lateralis</i>	LM	1
Thirteen-lined Ground Squirrel, <i>Spermophilus tridecemlineatus</i>	PG	1
Least Chipmunk, <i>Tamias minimus</i>	UM	1
Uinta Chipmunk, <i>Tamias umbrinus</i> *	UM	1
Unidentified chipmunks, <i>Tamias</i> spp.	UM	1
Red Squirrel, <i>Tamiasciurus hudsonicus</i>	LM, UM	3
Northern Pocket Gopher, <i>Thomomys talpoides</i>	E, LM, UM	3
Western Jumping Mouse, <i>Zapus princeps</i>	LM	1
Striped Skunk, <i>Mephitis mephitis</i>	LM	1
Raccoon, <i>Procyon lotor</i>	PG	1
<b>Birds</b>		
Northern Flicker, <i>Colaptes auratus</i>	PG, LM, UM	3
Steller's Jay, <i>Cyanocitta stelleri</i>	E	1
Black-billed Magpie, <i>Pica pica</i>	E	1
Western Tanager, <i>Piranga ludoviciana</i>	PG	1
European Starling, <i>Sturnus vulgaris</i>	PG	3
American Robin, <i>Turdus migratorius</i>	E	1

<sup>a</sup> Mammal names follow Jones et al. 1982.  
<sup>b</sup> Bird names follow American Ornithologists' Union 1983.  
<sup>c</sup> Identified by skeletal remains only.  
<sup>d</sup> Six mammals were identified to genera only, and 5 of these (*Sylvilagus*, *Microtus*, *Peromyscus*, *Sciurus*, and *Tamias*) may overlap items identified to species.  
<sup>e</sup> Nest area habitats include the following major ecosystem types: Plains Grassland (PG); Plains Grassland-Lower Montane Forest ecotone (E); Lower Montane Forest (LM); Upper Montane Forest (UM).  
<sup>f</sup> Blumstein, unpubl. ms.

County Audubon Society and Boulder County Nature Association helped me locate nests. The City of Boulder Open Space and Mountain Park Rangers, and G. Craig of the Colorado Division of Wildlife, provided helpful information. R. Weiser and the Getmans allowed me access to their land and Red-tailed Hawk nests. R. Adams, B. Gilbert, S. Pederson, and J. Strauch helped identify pellet contents. D. M. Armstrong, D. L. Evans, B. Jakob, M. R. Lein, R. K. Murphy, and J. R. Parrish helped improve previous versions of this paper. I was supported by a UCD Graduate Fellowship during manuscript preparation.

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- Department of Environmental, Population, and Organismic Biology, University of Colorado, Boulder, CO 80309. Present address: Animal Behavior Graduate Group, % Department of Zoology, University of California, Davis, CA 95616.**

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## Bald Eagle Kills Sharp-shinned Hawk

Jay R. George

Klem (*Wilson Bull.* 97:230-231, 1985) described several instances of diurnal raptors killing other diurnal raptor species. I witnessed a similar incident during raptor migration in the fall of 1985.

At 1005 H on 28 September 1985 two raptors were observed flying toward North Lookout at Hawk Mountain Sanctuary, Berks County (40°35'N, 75°55'W), in east-central Pennsylvania. The birds were first observed at a distance of approximately 1000 m and were approximately 50 m apart moving parallel to the ridge in a generally WSW direction. The larger of the 2 birds was identified as an eagle, the second bird as an accipiter. Less than 10 s after the initial sightings a third raptor, a smaller accipiter, approached the pair from behind and above and began harassing the eagle by diving repeatedly. At this point the larger accipiter (believed to be a Northern Goshawk [*Accipiter gentilis*] but identification was not certain), turned to the NW and passed the observation point on the north side of the ridge without further interaction with either of the other two raptors.

The small accipiter, judged to be a Sharp-shinned Hawk (*Accipiter striatus*) based on size and flight characteristics, made 3 passes at the eagle. Each pass was within centimeters of the bigger bird, causing it to turn quickly from side to side. Considerable distance from the observer to the birds made precise observation difficult, and the accipiter was unobserved for perhaps 3 s. The small raptor was next observed approximately 20 m below and in front of the eagle. The eagle dived but missed the smaller bird, which no longer moved with its previous speed and agility. The larger bird made 3 unsuccessful attempts at capturing the accipiter, but each time the smaller raptor pitched forward and downward with movements that indicated possible wing damage. On the fourth try the eagle successfully grasped the small accipiter in its talons.

The eagle, now clearly seen to be an immature Bald Eagle (*Haliaeetus leucocephalus*) carried its catch as it continued its flight parallel to the ridge. The eagle passed my observation site approximately 200 m to the south and 50 m above. As it did it lowered its head, struck its prey with

its mandible and passed behind me. The eagle circled back briefly and dropped the small raptor to the ground, apparently dead. The eagle then resumed its flight to the WSW.

Klem (1985) suggested that the causes for interspecific killing of raptors by raptors include: competition for food, competition for territory or breeding sites, and annoyance or defense. In the incident I observed, the Sharp-shinned Hawk repeatedly harassed the eagle, and the eagle did not eat the Sharp-shin after killing it. These behaviors suggest that annoyance was the cause.

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**RD6, Manheim, Pennsylvania 17545.**

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## THESIS ABSTRACTS

### REVERSED SIZE DIMORPHISM, DETERMINANTS OF INTRASPECIFIC DOMINANCE, AND HABITAT USE BY AMERICAN KESTRELS (*Falco sparverius*) WINTERING IN SOUTH CAROLINA

This study examines the importance of sex, age, weight, and residency on the dominance status of wintering American Kestrels (*Falco sparverius*), examines habitat segregation by sex in kestrels wintering in South Carolina and Maryland, and experimentally tests the female dominance hypothesis proposed to explain reversed size dimorphism in raptors. Kestrels were randomly paired in an arena containing food (a mouse) either in aviaries at Clemson University or in the field. During 20 minute observation periods, all interactions between birds were recorded. Females tended to dominate males, and heavier birds tended to dominate lighter ones. The female dominance hypothesis was supported. Although sample sizes were too small for strong conclusions, there were indications that age and residency are also important determinants of dominance. Field observations revealed no habitat segregation, either in South Carolina, or in Maryland, but did suggest strong non-random habitat use. Both sexes were found significantly more in open habitats, such as plowed fields, pastures, and meadows, and significantly less often in wooded and residential areas. **Aborn, David A. 1989. M.Sc. Thesis, Dept. of Biological Sciences, Clemson University, Clemson, SC 29634-1903, U.S.A. Thesis Advisor: Dr. Sidney A. Gauthreaux, Jr.**

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### BIOSYSTEMATICS OF THE GRAY HAWK, *Buteo nitidus* (LATHAM)

Systematic relationships and taxonomy of the Gray Hawk (*Buteo nitidus*) at the generic, specific and subspecific levels remain unclear despite much research. This paper attempts to clarify these relationships. One-way ANOVAs and discriminant function analysis indicated that allopatric North and South American Gray Hawk populations differ significantly in both plumage and morphometric characters. Populations were probably isolated >10 000–12 000 B.P., when expanding tropical moist forests closed a dispersal route for arid adapted species (e.g., the Gray Hawk) on the Pacific slope of Costa Rica. Differentiation of these forms is sufficient that it might result in reproductive isolation if the populations come into contact. They should be recognized as allospecies (*Asturina nitida* in South America and *A. plagiata* in North America; generic name change discussed below). Within both allospecies, size varies as predicted by Bergmann's ecogeographic rule. In the southern allospecies variation is generally continuous, but the population west of the Mato Grosso Plateau (*A. n. pallida*) should be considered a distinct subspecies from that found elsewhere in South America (*A. n. nitida*). Size variation in the northern allospecies is discontinuous on the Pacific slope of Mexico in southern Sonora and at the Isthmus of Tehuantepec. Differentiation of northern populations might be the result of post-Pleistocene and ongoing isolation events. The 3 populations defined by clinal discontinuities warrant subspecific status (*A. p. maxima*, *A. p. plagiata*, and *A. p. micra*). Factor and cluster analysis show that the Gray Hawk superspecies does not possess the derived structure of the feet and legs characteristic of *Buteo*, but is morphometrically more similar to the subbuteonine genus *Leucopternis*. Three other species usually placed in *Buteo*, the Roadside (*B. magnirostris*), Ridgway's (*B. ridgwayi*) and Red-shouldered (*B. lineatus*) Hawks are also very similar morphometrically to *Leucopternis* and to the Gray Hawk superspecies. Roadside, Ridgway's and Red-shouldered Hawks share a derived plumage character with the Gray Hawk superspecies, which suggests that together they comprise a monophyletic subbuteonine clade. This clade warrants recognition at the generic level under the oldest available name, *Asturina*. **Millsap, Brian A. 1986. M.Sc. Thesis, Dept. of Biology, George Mason University, Fairfax, VA 22039 U.S.A. Thesis Director: David W. Johnston, Ph.D.**

## DISSERTATION ABSTRACT

### WINTER ECOLOGY OF URBAN MERLINS (*Falco columbarius*)

A study of a non-migratory Merlin (*Falco columbarius*) population wintering in Saskatoon, Saskatchewan, Canada, was undertaken to examine how individuals cope with thermally stressful environment through behavioral and physiological means and to determine why some members of this urban-breeding population adopted a non-migratory strategy while others remain migratory. Merlins were trapped in the city each winter (1 November–28 February) for 5 years beginning in the winter of 1983–1984. Body mass, wing chord, total length, culmen and tail length were measured for all birds caught, and each individual was marked with a color-coded leg streamer. Selected individuals were fitted with radio-transmitters. Telemetry enabled me to maintain visual contact and continuously record the locations, movements and activities of a focal bird from roost departure until re-entry.

Standard respiratory gas exchange variables of 9 Merlins caught during the study were measured in an open-circuit respirometer to obtain estimates of basal and standard metabolic rates as well as activity costs for alert perch, feeding and preening (flight costs were estimated from allometric equations). Basal metabolic rate was higher in females (6.96 kJ/hr) than males (5.23 kJ/hr), but when placed in a time-energy budget model involving an electrical-analog of heat transfer, activity budget for birds in this population, and detailed meteorological measurements of the birds' habitat and microhabitat, resulted in energy budgets for winter season which did not differ between the sexes (35 908 and 35 487 kJ for female and male Merlins, respectively).

Winter home ranges of adult Merlins were more closely associated with their former nest site than those of yearlings to their natal nest site; adult males were closer to their next breeding site during winter than females. Close association of adult Merlins with former nesting sites is similar to patterns found in other birds. As well as the ability to maintain territory ownership, greater familiarity with the area around the nest may facilitate exploitation of local resources and enhance winter survival. In terms of overall habitat use Merlins showed preference for older residential areas of the city and avoidance of commercial-industrial and rural habitat. However, birds used commercial-industrial habitat for hunting at levels much higher than expected from availability in their home ranges. Hunting activity peaked at 0900 and 1600 H, possibly reflecting the need to replenish energy stores lost during overnight fasting and taking advantage of digestive heat by feeding just before roost re-entry at dusk. Primary prey species for Merlins wintering in Saskatoon were House Sparrow (*Passer domesticus*) and Bohemian Waxwing (*Bombycilla garrulus*), which together comprised 89% of the total number of prey and 92% of the total biomass observed being taken by Merlins in the city.

These data were analyzed in light of a recent northward expansion of Merlin wintering range which includes many towns and cities in the northern Great Plains. Mass-specific metabolism rates for males and females were about 50% higher than expected from allometric calculations; females had reduced lower critical temperatures and males had thermal conductances below expected values. Such cold tolerant physiological capabilities suggest that ecological, rather than physiological, factors formerly limited Merlin abundance on the Great Plains in winter. There were few significant differences in body morphometrics when adults and yearlings or migratory and non-migratory groups were compared. Non-migrant Merlins tended to have non-migrant parents, whereas migratory birds predominantly had migratory parents suggesting a potential genetic component to the development of migratory and non-migratory behaviour. Certain nesting areas in the city were occupied more frequently than others. Birds which wintered in the city nested in these preferred areas more often than would be expected by chance. This suggests that wintering in the city gives non-migratory birds some advantage in being able to obtain higher quality nesting areas. **Warkentin, Ian G., 1988. Ph.D. Dissertation. Department of Biology, University of Saskatchewan, Saskatoon, Saskatchewan S7N 0W0, Canada. Present address: Department of Veterinary Anatomy, University of Saskatchewan, Saskatoon, Saskatchewan S7N 0W0, Canada.**

## NEWS AND REVIEWS

### 1987 LESLIE BROWN MEMORIAL GRANT RECIPIENTS

#### Djibouti III—Migration Raptor Count

Geoff and Hilary Welch

(Note: An editorial oversight resulted in the following profile note being printed in an earlier issue of *The Journal of Raptor Research*. A sincere apology is extended to Geoff and Hilary Welch.—Editor)

As with previous Djibouti expeditions, Djibouti III was co-led by Geoff and Hilary Welch. Geoff and Hilary met in autumn of 1977 whilst working as temporary wardens for the Royal Society for the Protection of Birds (RSPB) at Minsmere Nature Reserve in Suffolk, England. Geoff graduated from Imperial College, London—reading Zoology and Applied Entomology—in July 1977, having studied avocets at Minsmere for his final year project. Hilary graduated in Graphic Design from the London College of Printing in July 1975. She had left college with a new but increasing interest in birds and conservation, so filled in the time before finding a job in design by working as a volunteer in the RSPB's southeastern office near her home.

After a year of working together at Minsmere, Geoff and Hilary were taken on as full-time wardens, Hilary being the first and only female warden with the RSPB. In September 1979 they were married, and in January 1980 Geoff was posted to his own reserve, Fairburn Ings, Yorkshire. In May 1986 they moved to a new reserve, the Nene Washes, Cambridgeshire, where Geoff is now tackling the challenge of managing a wet grassland reserve with livestock. Since July 1986 Geoff has been a member of Council for the Ornithological Society of the Middle East.

Encouraged by ICBP, Geoff and Hilary began the first Djibouti expedition (14 March–3 April 1984) which was a preliminary visit to examine the status of the endemic Djibouti Francolin (*Francolinus ochropectus*) and to document the country's almost unknown birdlife. Opportunities for observing migration, their main field of interest, were unfortunately very limited.

Between 9 October and 3 December 1985, the Djibouti II expedition carried out research into several aspects of the country's wildlife: raptor migration (>80 000 birds noted in 3 wks); more work on the Djibouti Francolin; a survey of the near-endemic Bankouale Palm (*Livistona carinensis*); and a brief survey of the endangered Arabian Bustard (*Ardeotis arabs*). During Djibouti II, a new subspecies of the Green-winged Pytilia (*Pytilia melba flavicaudata*) was discovered and described (published in *Sandgrouse*, Volume 10).

The Djibouti III project (23 September–18 November 1987) concentrated on further documenting raptor migration. During 38 days of counting, 246 478 raptors of 26 species were noted. The project also endeavoured to increase public awareness of birds, wildlife and conservation in Djibouti.

No immediate plans for future expeditions are underway, but Geoff and Hilary are collaborating with Alain Laurent, a teacher in Djibouti, on a bird book for use in Djibouti schools, as well as a distribution atlas of the country's avifauna. Attempts are also being made to establish a nature reserve on the outskirts of Djibouti city. Djibouti is a coastal city located in southeastern Afars and Issas Territory on the African continent at the juncture of the Red Sea and the Gulf of Aden.



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A more detailed set of instructions for contributors appeared in *J. Raptor Res.*, Vol. 21, No. 1, Spring 1987, and is available from the Editor. Send all manuscripts for consideration and books for review to the Editor.